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THE ROLE OF THE CRICOPHARYNGEAL MUSCLE IN CASES OF HYPOPHARYNGEAL DIVERTICULA

A CINEROENTGENOGRAPHIC STUDY

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ROENTGENOGRAPHIC studies of the mechanism of swallowing show how the pharynx and the upper part of the esophagus are opened by the forward and upward movement of the larynx during the second phase of swallowing.[1,4] At this stage the opening of the oropharynx to the nose is closed by the palate and in the same way the passage to the mouth is shut by the tongue. This gives a certain negative pressure in the hypopharynx, owing to the forward movement of the larynx which widens the previously closed pharyngeal cavity. This fact explains the well-known phenomenon of an exceedingly rapid movement of the bolus from the back of the tongue into the upper part of the esophagus. The negative pressure in this region draws the food into the esophagus. The next phase of importance in this connection is the rapidly following peristaltic movement starting from the epipharynx and running down to the cricopharyngeal muscle at the level of the larynx.

This important muscle, the cricopharyngeus, is normally in a state of contraction and thus acts as a sphincter at the upper mouth of the esophagus in the same manner as the cardia at the lower end. Normally, the neural reflex mechanism is arranged in such a way as to relax the muscle fibers at the very moment when the bolus reaches this region, and accordingly it allows the food to pass unobstructed.

When the larynx has moved back to its normal resting position, the posterior surface of the larynx again rests against the posterior pharyngeal wall. The mouth of the esophagus is then again closed by the cricopharyngeal muscle.

The reflex of the sphincter has been studied by section of different efferent nerve fibers by Sjöberg[5] in 1939, with the following results.

After a one-sided high section of the vagus nerve, the animals (cats) showed no difficulties in swallowing. Roentgenologically, there was no deviation from the normal. Also, after cutting of the cervical part of the sympathetic trunk, no symptoms from the act of swallowing could be observed.

When both vagi were cut, the upper and lower sphincters of the esophagus, the

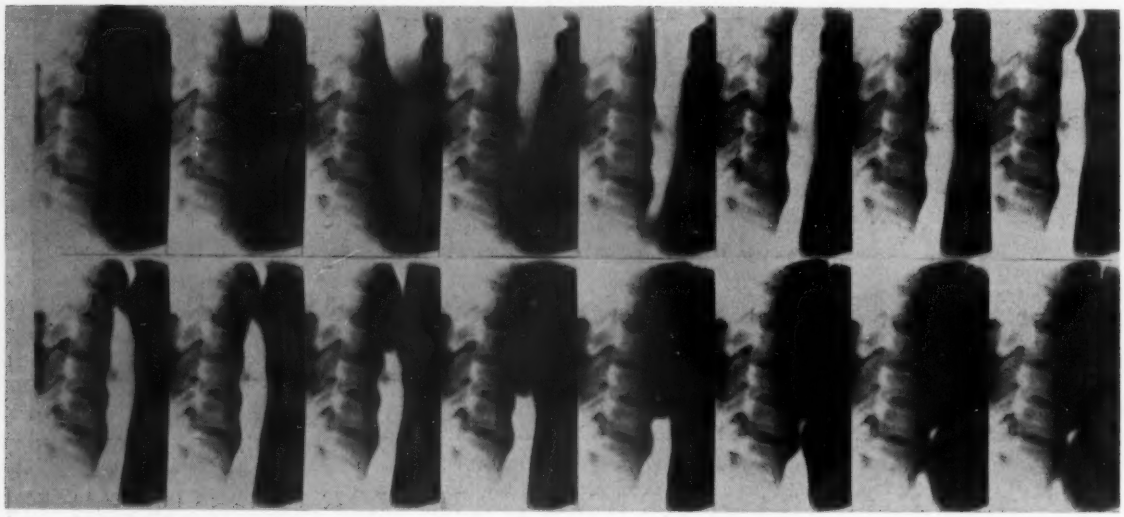

Fig. 1. Cineroentgenographic series showing normal swallowing in the lateral projection.

cricopharyngeus and the muscle of the cardia remained closed and the esophagus was paralytically distended.

Sjöberg concluded that "the oesophageal ostia are caused to contract by the adrenergic, sympathetic nerves, while the cholinergic vagus fibres bring about relaxation."

The complex reflex of swallowing is therefore dependent on the interplay of a pattern of neural pathways from both of these systems. It has been emphasized that paralytic neural defects appear to be an important cause in diverticular formation in the gastrointestinal canal. We have the impression that for the formation of diverticula of the hypopharynx in persons of advanced age, it must be of importance to consider the possibility of local neurofunctional defects causing distention, along with failure in the normal process of relaxation of the cricopharyngeal sphincter.

Cineroentgenographically, it is interesting to follow the course of the opening reflex of the cricopharyngeus as seen in cases of hypopharyngeal diverticula and compare it with that in normal persons. As a background to the diverticular case, cineroentgenographic series showing normal swallowing in the lateral and frontal projection are presented in Figures 1 and 2. In these it is possible to see how the mouth of the esophagus opens even before the bolus has reached the hypopharynx. This means that the cricopharyngeal muscle must be stretched, owing to its attachment to the cricoid cartilage, when the larynx moves forward. The posterior sector of the muscle ring is part of the posterior pharyngeal wall and cannot be torn away from the surface of the prevertebral muscles. It can easily be moved in all directions on the muscle layer owing to the loose prevertebral connective tissue, but it cannot be lifted away from the prevertebral surface. This is the same phenomenon as can be demonstrated, for instance, with two moistened glass plates if they are placed one on the other; they can easily be moved against each other but cannot without great force be lifted off from one another unless air or fluid is allowed to pass in between the two plates.

If the posterior hypopharyngeal wall is lifted by force, something must fill the space between the cricopharyngeal muscle in this wall and the prevertebral muscle layer. In this case this "something" must be some easily movable tissue or fluid from the surrounding spaces, *e.g.* from the posterior mediastinal connective tissue. Normally, this does not happen. In elderly persons developing a certain flaccidity in their tissues, loose tissue from the surrounding

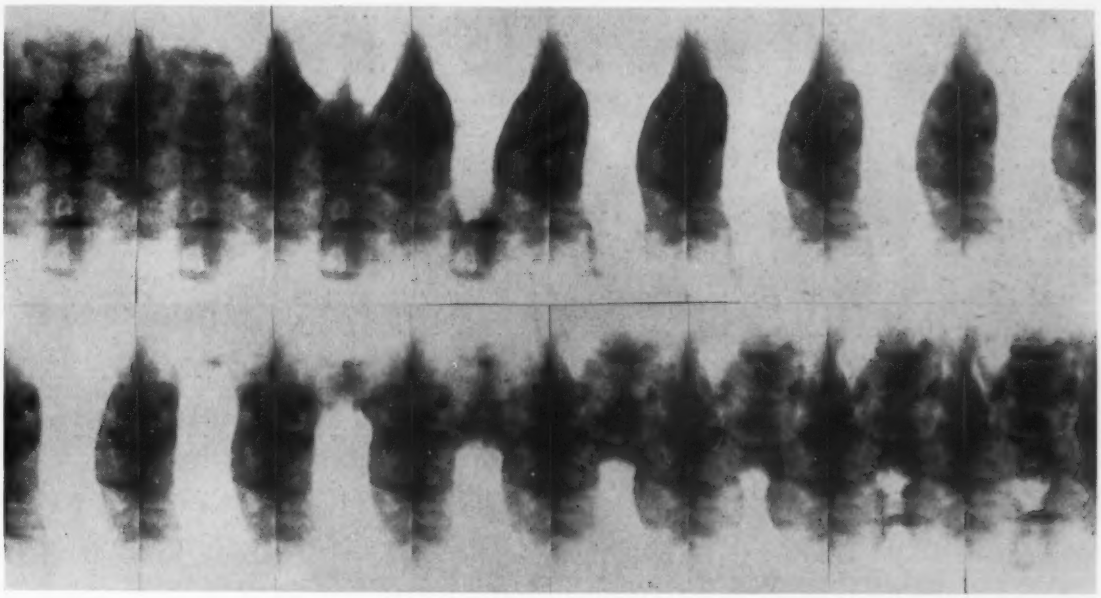

Fig. 2. Cineroentgenographic series showing normal swallowing in the frontal projection.

spaces, mediastinum or paravertebral space might be sucked in between the pharyngeal wall and the prevertebral muscle layer. This would appear roentgenographically as a typical variation of the distance between the vertebral column and the posterior pharyngeal wall at the level of the cricopharyngeal muscle (See Fig. 3, *A* and *B*,

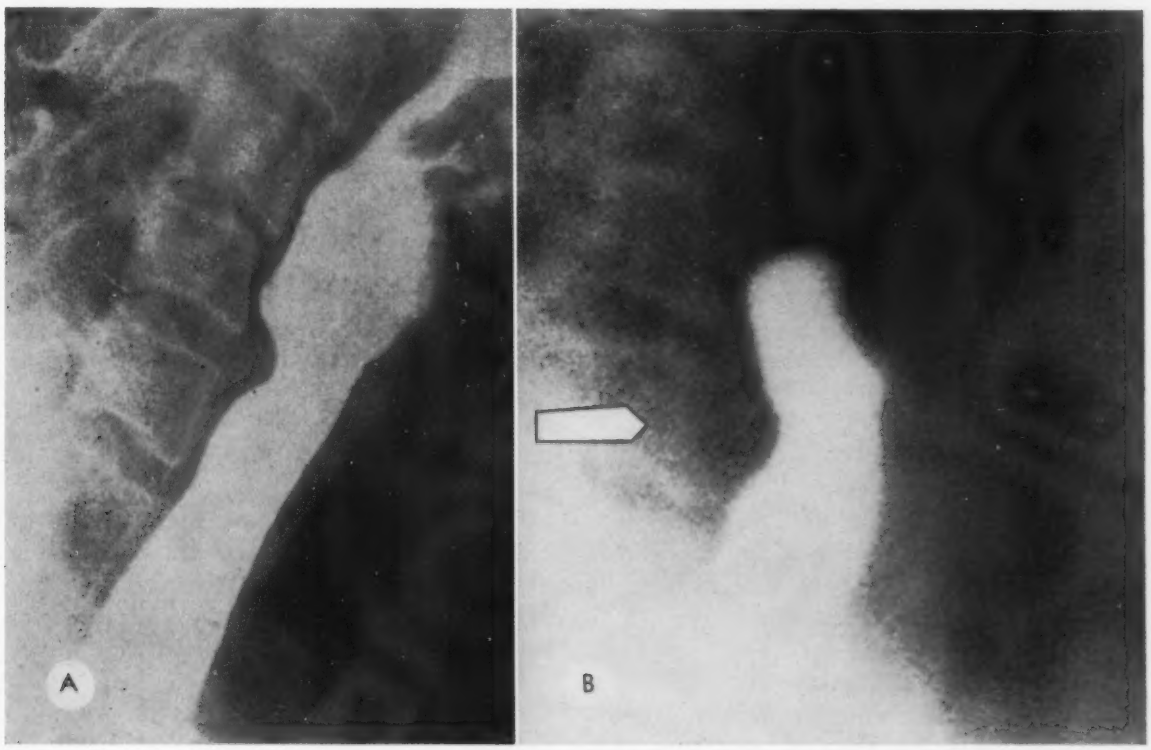

Fig. 3. (*A* and *B*) Variation of the distance between the vertebral column and the posterior pharyngeal wall at the level of the cricopharyngeal muscle (arrow) in an elderly person during swallowing.

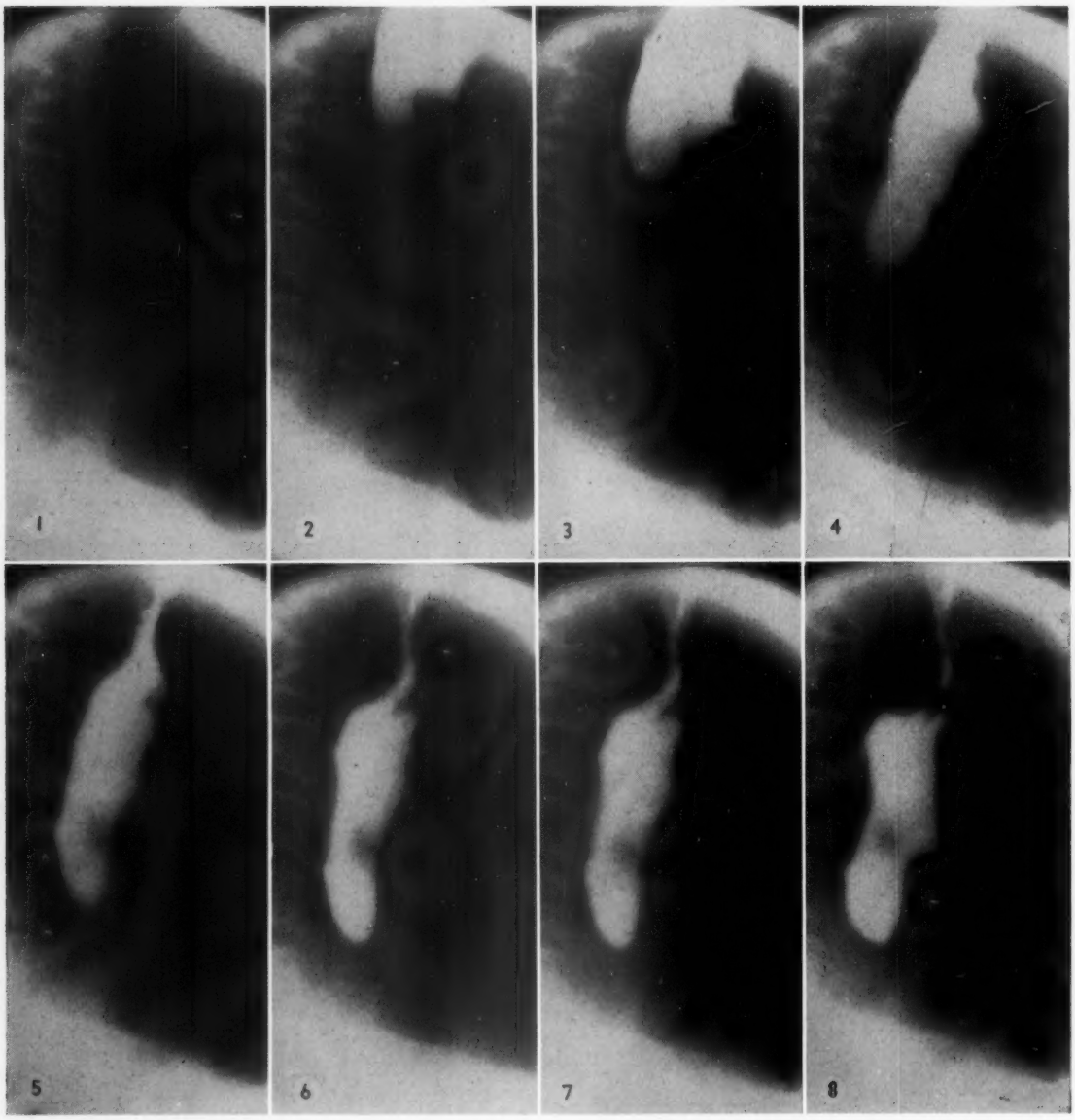

Fig. 4. Cineroentgenographic series showing continuous constriction of the "mouth" of the esophagus by the cricopharyngeal muscle bundle in the anterior diverticular wall (arrow) during swallowing.

after Holmgren[3]). There is a highly bulging thickening of the muscle. This finding has been described roentgenologically as being due to spasm or other neuromuscular disorder (Crichlow[2]) of the cricopharyngeus and is said to give often subjective symptoms of obstruction.

It is true that a spasm of the cricopharyngeal muscle would explain this roentgenologic picture. It would suggest a considerably hypertrophic muscle in the sphincter and would clarify the difficulties in swallowing.

If, however, we assume that the movement of the larynx upwards and forwards is of prime importance in the interplay of reflexes which open up the hypopharynx at an early stage of swallowing, then this movement would normally stretch the cricopharyngeal muscle fibers. We may also surmise that stretch-receptors in these muscle bundles may take part in the initia-

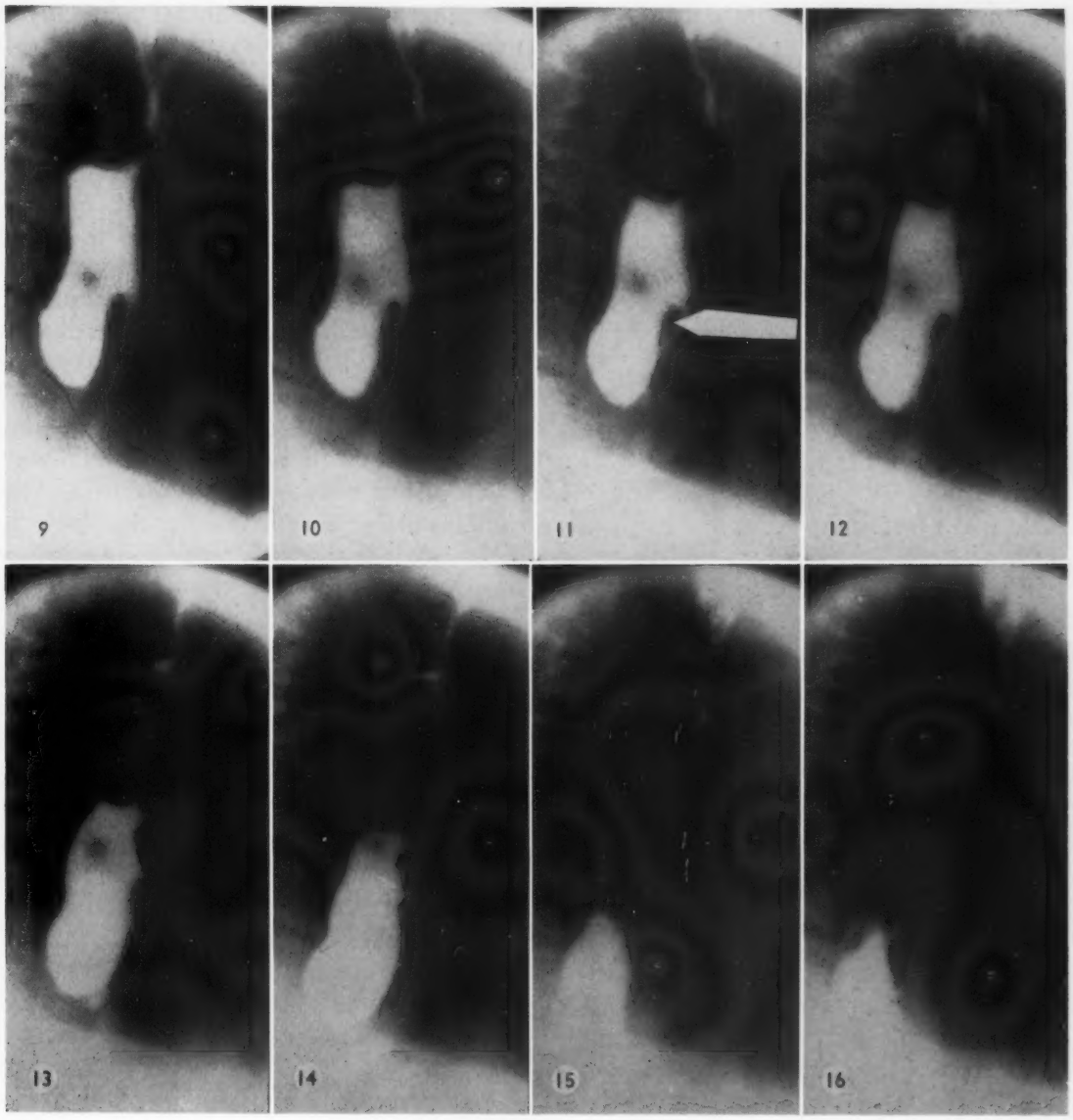

Fig. 4—(*Continued*)

tion of the reflex, which results in a relaxation of the cricopharyngeal sphincter. Most endoscopists have probably made the observation that when the esophagoscope is passed through the hypopharynx, the resistance of the sphincter easily yields to a slight stretching pressure. Furthermore, the sphincter suddenly relaxes when the patient makes a swallowing movement even before the esophagoscope has reached the cricopharyngeus. This might suggest that more than one pathway in this neural reflex pattern is involved in the complicated process which results in a relaxation of the cricopharyngeal sphincter. If the posterior hypopharyngeal wall were not attached to the prevertebral layer, the forward movement of the larynx would not be able to stretch the cricopharyngeus. This, then, would result in a failure or insufficiency in opening and would produce the same symptoms as the "spasm." A movement of the larynx forwards would carry the sphincter with it, the muscle bundles would not relax and this

would appear roentgenographically as a bulging of the muscle in the posterior wall. Such a failure in opening the cricopharyngeus would accordingly cause difficulties in swallowing along with a feeling of obstruction.

In this connection it seems important to refer to the fact that in cases of very small "inconstant" diverticula as described by Holmgren[3] and others, this bulging of the cricopharyngeal muscle is particularly pronounced. It is also important to note that these small diverticula do not appear on the roentgenogram when the food bolus is passing through the hypopharynx while a negative pressure still prevails, but are visible when a raised pressure in the hypopharynx is induced by the peristaltic wave, forcing the remaining food contents into the esophagus. Thus, the raised pressure is probably the main reason for the outpouching of these small diverticula at the concluding stage of the act of swallowing under the circumstances mentioned.

It is apparent that for some reason more loose tissue can be mobilized and "sucked" in between the muscle fibers of the cricopharyngeus and the prevertebral muscle layer and that the posterior pharyngeal wall will follow the forward movements of the larynx to a greater extent than ordinarily. As a consequence, the muscle fibers will not be stretched to a normal degree. If the relaxing reflex of the muscle, as we have reason to believe, is to a certain extent dependent on the stimulation of the stretch-receptors, this could result in a delayed or insufficient opening reflex with a feeling of obstruction at swallowing.

In the literature on this subject, the presence of a weak triangle in the posterior pharyngeal wall just above the circular fibers of the cricopharyngeal muscle is considered a factor of importance for the development of a diverticulum. Under normal conditions, however, this part of the wall is supported by the prevertebral muscle layers, and there is also no obstruction which can cause an abnormally high pressure in the pharyngeal lumen. Presumably, conditions which can facilitate a bulging of this weak triangle can only be expected if the cricopharyngeal muscle is lifted forward in the way here described by the laryngeal movements. If a layer of loose connective tissue is present behind the pharyngeal wall, a raised intrapharyngeal pressure could produce a "herniation" of the weak part of the wall. Deprived of the support of the prevertebral muscle layers, this part of the pharyngeal wall would be the *locus minoris resistentiae* and so give way to the bulging of a presumptive diverticulum.

In the already developed diverticulum, the mechanism involved in the swallowing of a food bolus is found to be essentially the same as under normal conditions. The only difference is that in this case *the diverticulum* is opened by the forward movement of the larynx. The cricopharyngeus cannot be stretched since it has lost its attachment to the prevertebral fascia, and the hypopharynx and upper part of the esophagus therefore remain closed. The food enters the diverticulum and the peristaltic wave in the last phase of swallowing causes a raised pressure which forces the food deeper into the pouch and distends its walls. The increased pressure is, however, usually sufficient to partly overcome the obstruction by the non-relaxing cricopharyngeal muscle and thus allows some food to pass into the esophagus. This can easily be seen in Figure 4.

A consequence of the herniation of the diverticulum from "the weak triangle" above the sphincter of the cricopharyngeus is that it dissects itself into the loose connective tissue of the prevertebral space and thus separates totally the cricopharyngeus from its normal close attachment to the prevertebral muscle layer. The whole muscle ring of the cricopharyngeus is thus bound to the larynx and follows the larynx in all its movements during swallowing. When the larynx moves forwards and upwards, the cricopharyngeus cannot be stretched because the posterior pharyngeal wall with the cricopharyngeus has become the anterior wall of the diverticulum. This

seems to be the reason for the failing opening reflex of this sphincter, giving the typical roentgenographic appearance of continuous constriction of the "mouth" of the esophagus by the cricopharyngeal muscle bundle in the anterior diverticular wall (Fig. 4). This gives us a clue to the principles for operation on these diverticula. By conventional resection of the diverticulum, it is possible to produce a new attachment to the prevertebral fascia by means of the unavoidable scar formations. Then the cricopharyngeus will be stretched again by the movements of the larynx and the opening reflex is re-established. The second possibility is the endoscopic operation of Dohlman, where the diverticular esophageal wall with the enclosed cricopharyngeal muscle is divided by surgical diathermy. In this way the muscle ring is cut into two halves, the obstruction is removed and the diverticulum empties directly into the esophagus.

Cineroentgenographically, the cricopharyngeal muscle can be seen to follow the whole cycle of movements of the larynx. From enlarged prints of the frames it is possible to analyze the movements of the larynx and the relevant anatomic structures. Figure 5, for example, shows the air cushion which precedes the bolus of food.

The diverticulum usually develops on the left side. This is because the upper esophagus is located slightly to the left, thus enhancing the possibilities for a distention into the paratracheal space on this side. As can be seen in Figure 6, the greatest obstruction is found on the left side of the hypopharynx, due to the pressure exerted by the filled diverticulum. It seems natural that on the side where the bulging of the diverticulum is most pronounced, the cricopharyngeal muscle might be almost ineffective in relaxing and opening the hypopharyngeal lumen, thereby leaving no open passage for the access of food. On the right side, however, there might be some connections left between the muscle fibers and the posterior wall, which could open the right pyriform sinus and allow a small trickle of

Fig. 5. Enlarged print of a cineroentgenographic frame showing the air cushion (arrow) which precedes the bolus of food during swallowing.

contrast medium to pass into the esophageal lumen, where the esophagus is still in its normal juxtamedial position.

As may be noted in the cineroentgenographic series of Figures 4 and 6, the diverticulum sinks into a resting position when the act of swallowing is completed. During swallowing, however, the diverticulum is filled under pressure. When the muscle of the pharyngeal wall and the neck are relaxed, the overfilled diverticulum will partly empty itself back into the hypopharynx. These regurgitations irritate the mucous membrane and give rise to repeated cycles of re-swallowing. When the patient makes an effort to swallow, the regurgitated

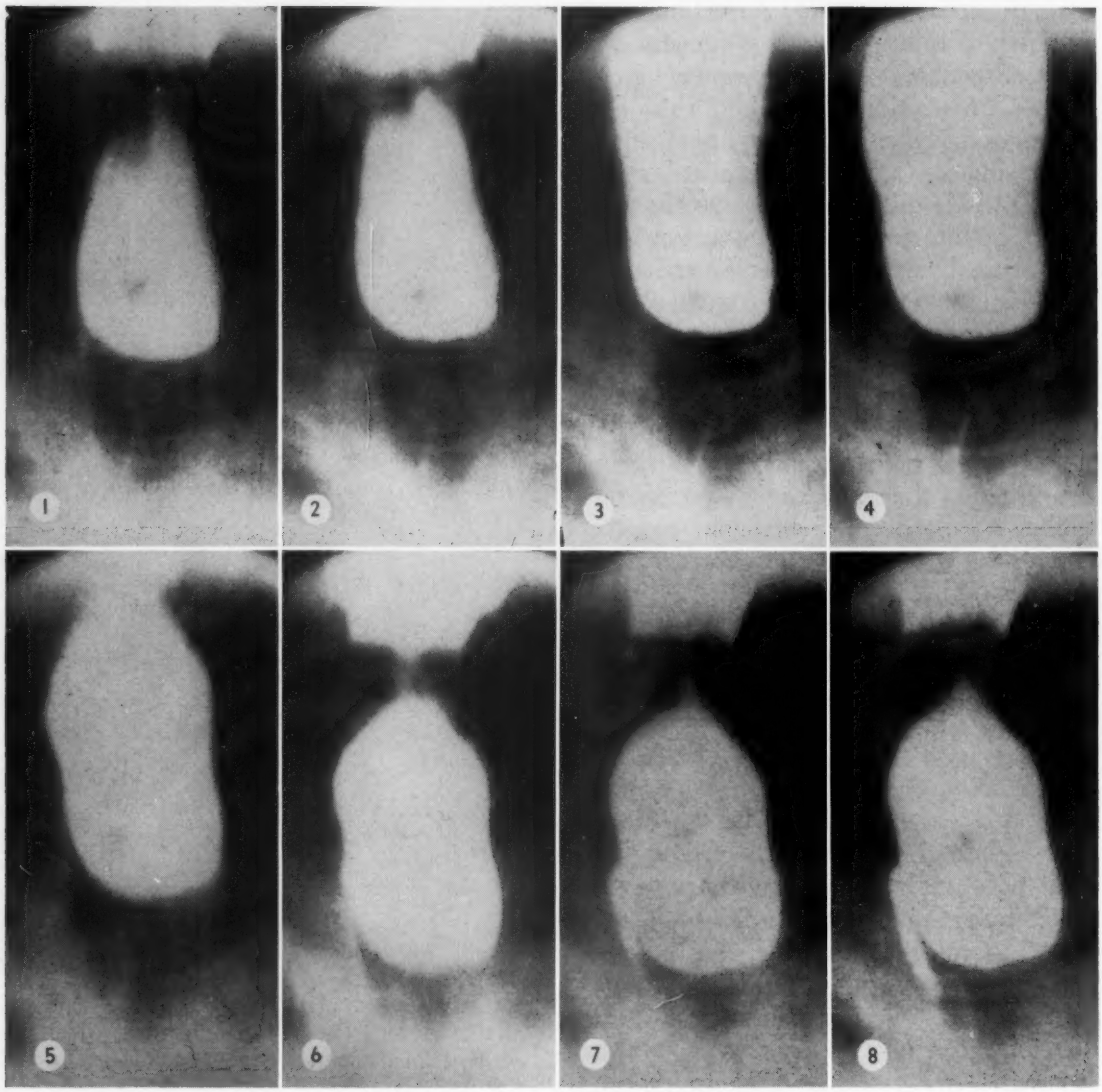

Fig. 6. Cineroentgenographic series showing diverticulum on the left side with trickling of barium into the esophageal lumen where the esophagus is still in its juxtamedial position.

food or fluid from the diverticulum is again forced back, mostly into the pouch and, to some extent, into the esophagus. Air from the hypopharynx is in most instances pressed down into the pouch (Fig. 5) and, after mixing with the fluid and saliva, it produces gurgling noises, embarrassing to the patient and to those present at the table. Due to this regurgitation the pharyngeal mucous membrane is constantly exposed to irritation, eventually leading to chronic pharyngeal discomfort. In diverticula the normal physiologic cleansing of the pharyngeal mucous membrane by the peristaltic wave in the last phase of swallowing is incomplete owing to the continuous regurgitation of food particles.

SUMMARY

The well known symptoms in cases of diverticula: obstruction, gurgling noises, and pharyngeal irritation, causing re-

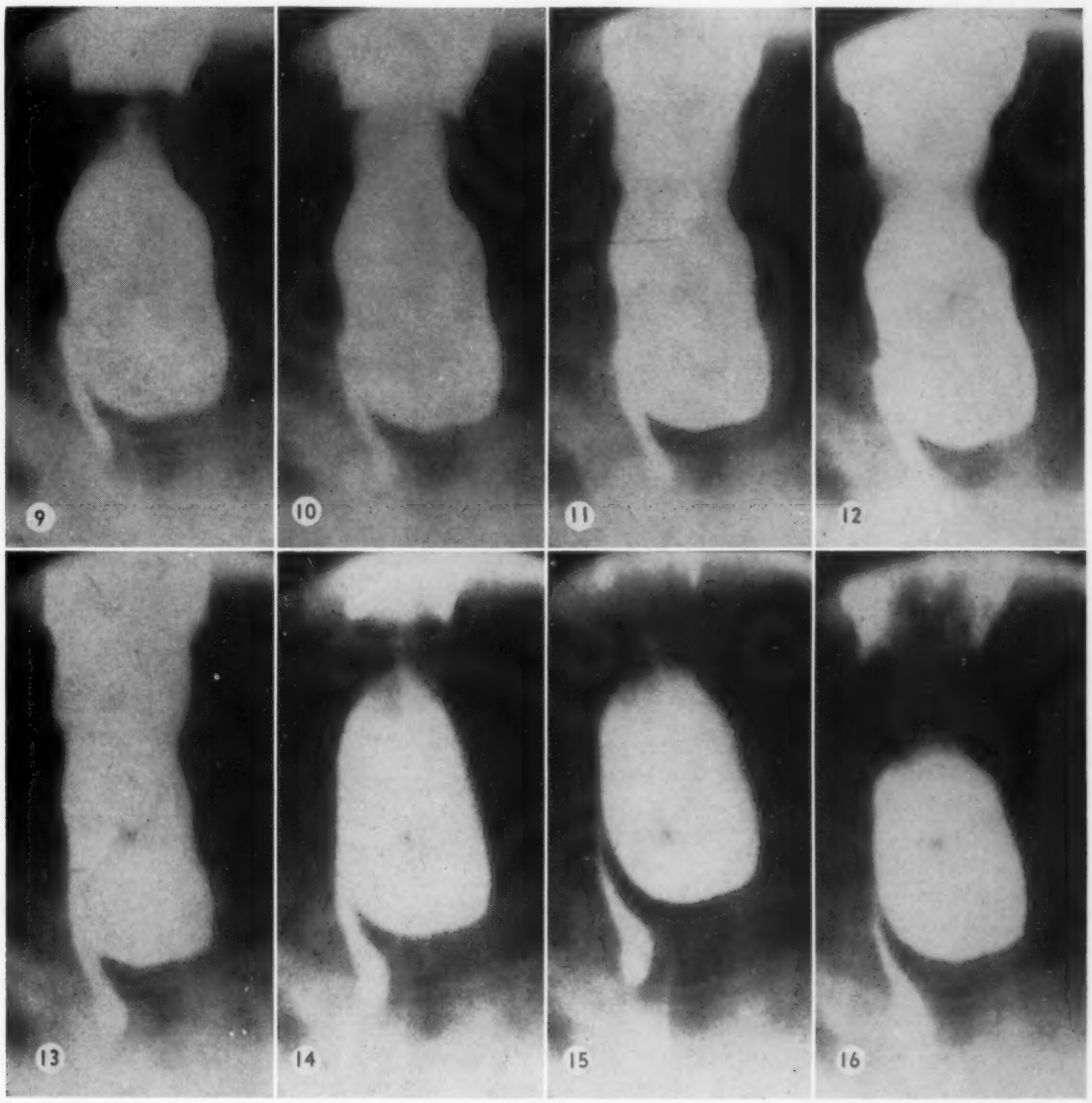

Fig. 6—(*Continued*)

peated impulsive attempts at swallowing, are discussed and the findings are demonstrated by cineroentgeonographic analysis.

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VARIATIONS IN THE ROENTGEN APPEARANCE OF THE "ESOPHAGEAL LIP"*

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NONOPACIFICATION of the cervical esophagus in routine esophagrams frequently occurs since the contrast material normally passes through this area at a rapid rate. The exposure is often inadvertently made after, instead of during, the act of swallowing, resulting in poor visualization of the segment in question. Consequently, the radiologist may not be as familiar with the normal or near normal variations in the roentgen appearance of the cervical segment of the esophagus as he is with the remaining esophageal segments. This paper is presented with the purpose of calling attention to the relatively frequent appearance of the "esophageal lip."

The endoscopic appearance of the junction of the hypopharynx and esophagus was first described by Killian.[4] He observed the presence of a transverse fold on the posterior wall of the esophagus at its junction with the hypopharynx. He named this bulge the "esophageal lip," and believed it was caused by the transverse portion of the cricopharyngeus muscle. Buckstein,[1] in describing the roentgen appearance of the esophagus at its origin, states that a concave indentation is occasionally observed on the posterior portion of the barium-filled proximal esophagus. In describing this indentation he remarks that it shows considerable variability in degree, extent and length of segment involved. He, too, postulates that it is caused by the cricopharyngeus muscle. Jönsson,[3] in a publication on the roentgen appearance of the esophageal lip, cautions that this bulge is frequently ascribed to an abnormal swelling of the mucous membrane secondary to a foreign body caught in the esophagus at this level and concludes that the part played by mucous membrane swelling requires guarded interpretation and further investigation. In our department this very differential between possible mucous membrane swelling secondary to a foreign body and a prominent esophageal lip produced considerable discussion in the following case.

REPORT OF A CASE

A sixty-five year old white male, known mild diabetic, was admitted because of failing vision secondary to bilateral cataracts. While in the hospital, a piece of meat or food became lodged in his throat causing considerable discomfort. After vomiting, the food was dislodged but the patient complained of subsequent dysphagia. On the day following this episode, a lateral roentgenogram of the neck showed an increase in the prevertebral soft tissue density opposite C-6 and C-7, and a cervical esophagram (Fig. 1*A*) showed a smooth anterior displacement of the barium-filled esophagus at the same level. Spot roentgenograms confirmed the presence of this bulge. The possible explanations for the finding were: (1) a prominent esophageal lip; (2) cricopharyngeal spasm; (3) focal edema of the esophageal mucosa secondary possibly to a nonopaque foreign body embedded at this site; and (4) a benign intramural extramucosal neoplasm at this site which may have been responsible for the episode described above.

On the following day, the patient was esophagoscoped and the esophagoscopist reported visualizing a perfectly normal mucosa in the area in question with no evidence of inflammatory changes, foreign body or mass. The patient's dysphagia subsided and has not recurred to date, a follow-up period of thirteen months. A repeat cervical esophagram (Fig. 1*B*) thirteen

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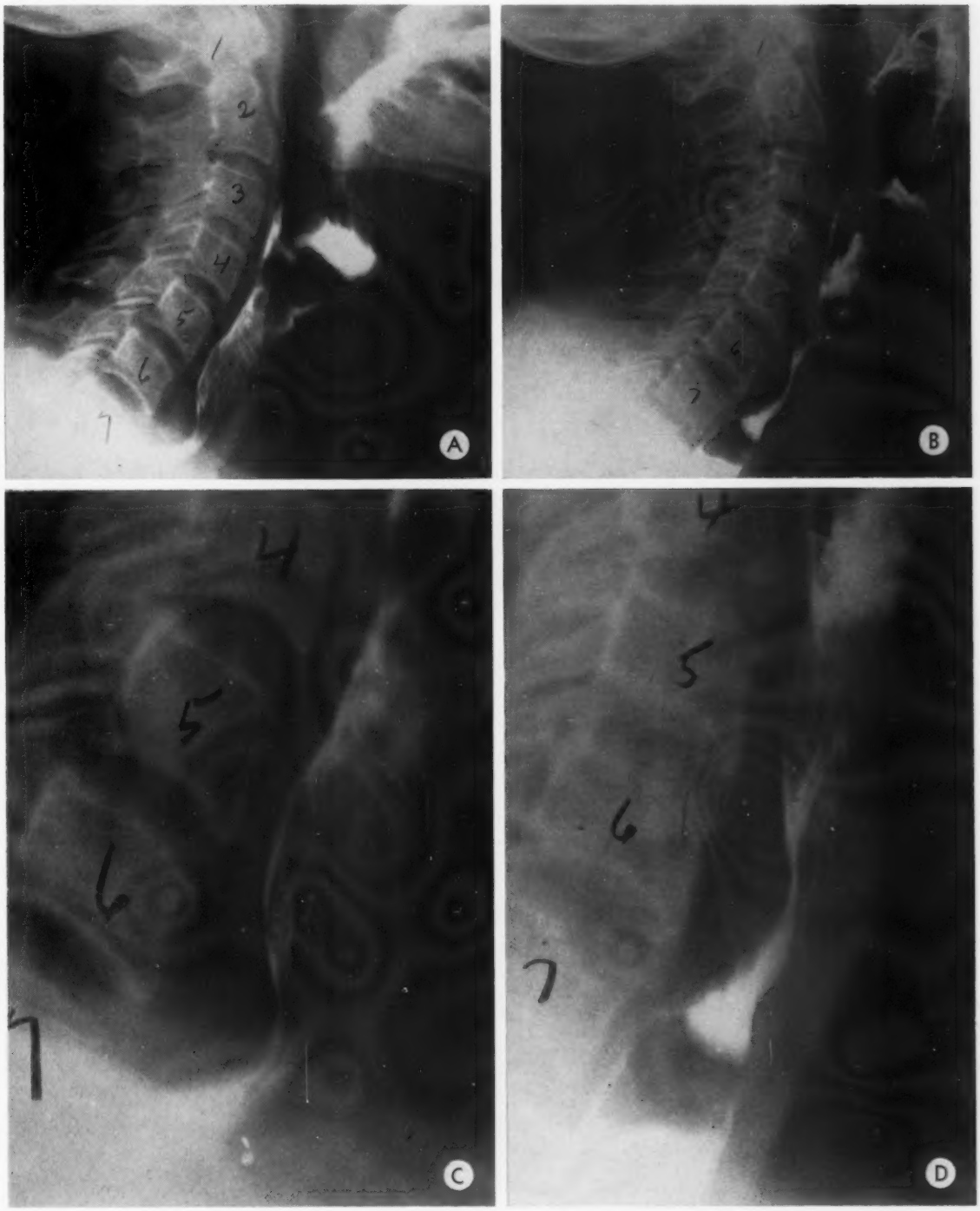

Fig. 1. (*A*) Cervical esophagram taken one day after patient had an episode of a piece of food being "stuck in throat," dislodged after vomiting, and followed by subsequent dysphagia. (*B*) Cervical esophagram thirteen months later. Patient was asymptomatic at this time and had had no complaints of dysphagia in the interim. (*C*) Enlarged view of *A*. (*D*) Enlarged view of *B*.

months after the original study showed a smooth anterior displacement of the cervical esophagus at the same level, but not quite as prominent, as on the original study. On this latest study a decrease in the size of the prevertebral soft tissue at this level was also noted.

This case prompted us to investigate the variation in the appearance of the cervical esophagus in asymptomatic patients. From patients referred to our department for gastrointestinal or small bowel studies in a period of one month, 50 patients having no complaints referable to dysphagia or neck pain were selected. Each patient had a cervical esophagram consisting of an anteroposterior and both lateral roentgenograms of the neck taken at a six foot distance with the patient in standing position,

Fig. 2. Examples of variations in the appearance in the lateral view of the barium-filled cervical esophagus found in our investigation of 50 asymptomatic patients. (*A*) No bulge. (*B*) Slight bulge. (*C*) Moderate bulge. (*D*) Pronounced bulge. Note: In different patients, the bulge is seen at various levels unrelated to spur level.

and while swallowing a mouthful of thick barium. The patients, all male, ranged in age from twenty-two to seventy years. The degree of indentation on the posterior aspect of the barium-filled esophagus was arbitarily evaluated on lateral roentgenograms by the following criteria:

1. No bulge: If the posterior wall of the barium-filled lumen presented a smooth unbroken curve (Fig. 2*A*).

2. Slight bulge: If a focal bulge anteriorly was demonstrated, a line was drawn on the roentgenogram indicating the course the posterior wall would take if no anterior displacement were present. From the actual posterior wall at the apex of the bulge to the projected posterior wall, a measurement was made. If this measurement was less than 5 mm. the bulge was classified as slight (Fig. 2*B*).

3. If the measurement described above was between 5 and 8 mm., the displacement was classified as moderate (Fig. 2*C*).

4. If the measurement of the distance described above was greater than 8 mm., it was classified as pronounced (Fig. 2*D*).

The case that prompted the study had a displacement which measured 9 mm. and would therefore be classified as pronounced.

In Table 1 are shown the age distribution of the patients and the presence and extent of the bulge demonstrated. It can be seen that this bulge is observed more frequently and becomes more prominent in the older age group. It seems to bear no relationship to body build and is also not directly related to the degree of demonstrated spur formation noted in the cervical spine. Figure 3*A* shows roentgen evidence of osteoarthritis of the cervical spine with a pronounced bulge, yet in Figure 3*B* there is even more evidence of osteoarthritic changes and spur formation in the cervical spine and no bulge on the posterior wall of the esophagus is demonstrated. In one patient of the series, however, a moderate anterior bulge was demonstrated at the level of C-6 and C-7 where very marked focal arthritic changes were noted (Fig. 3*C*). Considering the fact that this patient was thirty years old and that in no other patient of this age group was such a prominent bulge seen, it seems probable that in this case the arthritic changes at this level may have played an etiologic role. The references in the literature to the esophageal lip usually reported it as occurring at a level with the transverse process of C-6. In our series, however, the bulge, while always noted to be in the same position in the same patient on both laterals, and on laterals taken in the same patient at a later date, did vary in location from patient to patient. It was noted to occur at levels extending from anterior to the body of C-6 to anterior to the body of T-1 (Table II). The level at which the bulge was seen seems to bear no relationship to age nor to the prominence of the bulge itself or extent of the segment involved and was not influenced by exaggerated phases of respiration. Whether this in truth represents the cricopharyngeus as has been postulated has not as yet been investigated by us.

Crichlow[2] is of the opinion that the bulge

Table I

AGE DISTRIBUTION AND DEGREE OF BULGE

Age	Patients	No Bulge	Slight Bulge	Moderate Bulge	Severe Bulge
20–29	10	8	2	0	
30–39	16	4	11	1	
40–49	9	1	8		
50–59	4	0	3		1
60–70	11	1	5	4	1
Totals	50	14	29	5	2

Table II

Location of the "Esophageal Lip" in Relation to Cervical Vertebral Level	No. of Cases
Opposite body of C-6	7
Opposite C-6–C-7 interspace	18
Opposite body of C-7	8
Opposite C-7–T-1 interspace	3
No bulge on barium-filled cervical esophagus demonstrated	14

Fig. 3. (*A*) Pronounced bulge noted in presence of moderately severe osteoarthritic changes of cervical spine. (*B*) No bulge, yet roentgen evidence of cervical osteoarthritis is equally or more pronounced than in *A*. (*C*) Thirty year old patient with moderate bulge—in this case probably secondary to the focal arthritic changes at the same level.

in question is caused by the cricopharyngeus, but emphatically states that this bulge is never visualized in the normal. He feels that when seen it represents some degree of spasm of the cricopharyngeus and therefore evidence of dysfunction of the esophagus. He concludes that roentgenographic visualization of the cricopharyngeus is of definite pathologic significance. In his article he quotes Johnstone (1946 and 1952) as stating in "Non-malignant Conditions of the Esophagus" that "the rounded shelf-like defect, which is considered to be produced by the cricopharyngeus . . . occurs in patients with no dysphagia, and is of no definite pathologic significance," and sharply disagrees with this conclusion. Our findings tend to support Johnstone's contention since all our patients were asymptomatic as regards past or present dysphagia and had no known disease in the region of the pharynx or esophagus. In our study

bulges similar to Critchlow's Stage I degree of indentation seemed to have no definite pathologic significance.

SUMMARY

A review of the radiologic literature points up the need for a specific study of the so-called esophageal lip. Fifty male patients had anteroposterior and lateral roentgenograms of the esophagus taken, and the frequency and extent of the smooth bulge on the posterior wall of the esophagus were noted. It was observed to be situated at various levels from C-6 through T-1, but always at the same level in the same patient. It appeared more frequently and was more prominent as age increased, without definite relation to spur formation of the cervical spine. Presumably, it is produced by the transverse fibers of the cricopharyngeus muscle. It is well to bear in mind this variation in appearance of the posterior wall of the cervical esophagus in asymptomatic patients when interpreting this area for possible pathology.

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THE ROENTGEN APPEARANCE OF THE STOMACH AND DUODENUM FOLLOWING THE BILLROTH I GASTRIC RESECTION

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MATERIAL

TO OBSERVE the roentgen appearance of the stomach and duodenum following the Billroth I gastric resection, the records of 60 patients selected at random who had undergone this procedure during the period from March, 1954 to September, 1957 were reviewed and evaluated. The patient data from the charts and all available roentgenograms were studied. Of these 60 patients, 11 had only one follow-up roentgenographic study, whereas the remaining 49 cases were examined more frequently. The postoperative observation period is shown in Table I, the age and sex distribution in Table II, and the indications for operation in Table III.

Table I

POSTOPERATIVE OBSERVATION PERIOD

Observation Period (yr.)	$<\frac{1}{2}$	$\frac{1}{2}$–1	1–2	2–3	3–4	>4	Total
No. of Patients	2	4	17	22	10	5	60

Table II

AGE AND SEX DISTRIBUTION OF 60 PATIENTS OPERATED UPON

Operative Procedure	Age (yr.)																				
	21–30			31–40			41–50			51–60			61–70			71 and over			Total		
	Sex																				
	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total
Billroth I Operation without Vagotomy					2	2	7	5	12	10	4	14	2	6	8	2	2	4	21	19	40
Billroth I Operation with Vagotomy	1	1	2	1		1	6	2	8	5	1	6	2		2	1		1	16	4	20
Total	1	1	2	1	2	3	13	7	20	15	5	20	4	6	10	3	2	5	37	23	60

Table III

INDICATIONS FOR GASTRIC RESECTION

Operative Procedure	Indication									
	Duodenal Ulcer	Deformed Duodenal Bulb	Gastric Ulcer	Gastric Carcinoma	Gastric Hamartoma	Prolapsed Gastric Mucosa	Adult Pyloric Hypertrophy	Gastrointestinal Bleeding	Marginal Ulcer	Total
Billroth I Operation without Vagotomy	9	2	20	3	1	2	1	2		40
Billroth I Operation with Vagotomy	11	7	1						1	20
Total	20	9	21	3	1	2	1	2	1	60

* Fellow, China Medical Board.

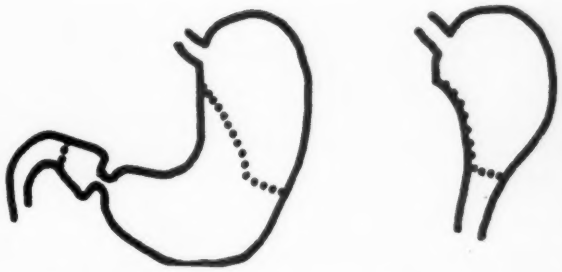

Fig. 1. Diagram of the operative procedure.

OPERATIVE PROCEDURE

All operations were performed according to the modification of Schoemaker on the Billroth I technique. Of the 60 patients, 20 underwent a bilateral vagotomy at the same time. In this procedure the resection is higher at the lesser than at the greater curvature. The defect on the lesser curvature is closed first with a continuous suture which is then inverted into the gastric lumen by another series of individual serosal sutures (Fig. 1).

POSTOPERATIVE ROENTGENOGRAPHIC APPEARANCE

The Gastric Stump. Due to the reconstruction of the lesser curvature as described, the lesser curvature showed an irregular contour in most cases[1,3] (Fig. 2). This irregularity was especially marked in one or two places in about 50 per cent of our cases. Occasionally, the lesser curvature appeared smooth postoperatively except for a localized irregularity which roentgenographically suggested recurrent ulceration (Fig. 3). This difficulty was encountered in 5 of the 60 cases. Repeat examinations revealed that the suspected areas were artifactual and represented small pouch-like protrusions of the mucous membrane between two individual sutures used for reconstruction of the lesser curvature.

Three of the 60 cases showed smooth, sometimes irregular filling defects, 1 to 3 cm. in diameter, protruding about 1 cm. into the lumen. These filling defects were situated on the lesser curvature, below the cardia, not in the proximity of the stoma (Fig. 4). They were considered possibly neoplastic in nature, although the mucosa

Fig. 2. Irregular contour on the lesser curvature, five months after Billroth I operation without vagotomy. The patient is clinically well.

was not disorganized. Repeat examinations showed that these lesions remained unchanged even after many months; we, therefore, feel that they arise following ir-

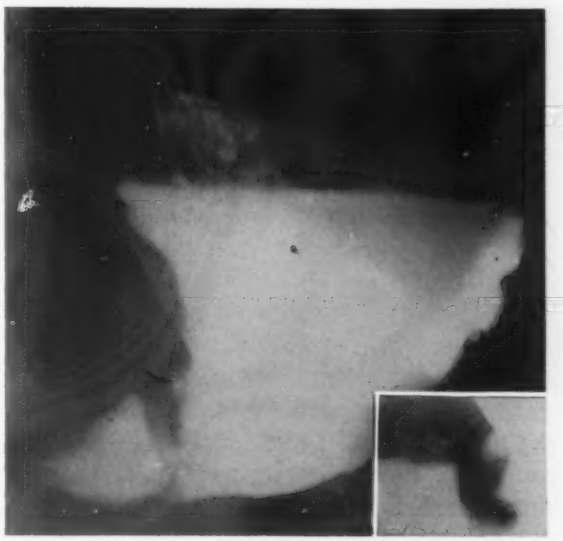

Fig. 3. Pseudo-ulcer on the lesser curvature (arrow), eighteen months after Billroth I operation with vagotomy. This pseudo-ulcer has remained constant on all postoperative examinations. Retention was noted sixteen months after operation. The patient is well, with only occasional complaints.

Fig. 4. Tumor-like filling defect on the lesser curvature (arrows), fourteen months after Billroth I operation without vagotomy. This constant defect was noted on all postoperative examinations. Gastric cytologic studies showed no evidence of malignancy. The patient is clinically well.

regular suturing of the lesser curvature. Other cases showed smaller filling defects, obviously due to retained food.

The size and configuration of the mucosal folds in the pre-anastomotic part of the gastric stump (and also in the postanastomotic part of the duodenum) depend on mechanical factors secondary to the operative technique and may be due to a disparity in the width of the gastric and duodenal ends of the anastomosis, especially in the functional postoperative state. At surgery one or two fingers can be passed through the anastomosis. One to two weeks postoperatively, roentgenograms demonstrated the maximum diameter of the stoma to be 0.5 to 1.5 cm. and 1 to 2 cm. after edema had subsided. This disparity may be a result of anesthesia which acts as a relaxant and thus causes elongation of the gastric wall.[5]

Except for these anatomic considerations, postoperative edema appeared to play a definite part in causing an increase in the size of the folds, thus narrowing the anastomosis. When the edema disappeared, within weeks or months after the operation the lumen of the stoma widened.

Anastomosis and Pre-Anastomotic Part of the Gastric Stump. The term "normal roentgenographically" was used when the mucosal folds in the pre-anastomotic part of the gastric stump in the follow-up period compared roughly to the size of the mucosal folds in corresponding sections of the normal stomach (Fig. 5). Folds exceeding this size were termed "enlarged" (Fig. 6 and 7). Obstruction, as shown in Figure 9, was defined as marked hindrance of barium passage through the stoma during examination, often continuing for hours and even several days. It corresponded clinically to a feeling of fullness and was often associated with vomiting. This obstructive phenomenon diminished in all cases a few weeks after the first examination, with some residue, apparently due to regression of the edema. Retention was defined as an insufficient and delayed passage of barium through the stoma although the patients examined had all fasted prior to examination. Insufficient resection of the stomach produced an acute angulation at the gastroduodenal anastomosis (Fig. 8). This may interfere with proper gastric emptying. A large residual gastric stump may also be an important

Fig. 5. Normal sized mucosal folds, two and one-half months after Billroth I operation without vagotomy. The patient is well.

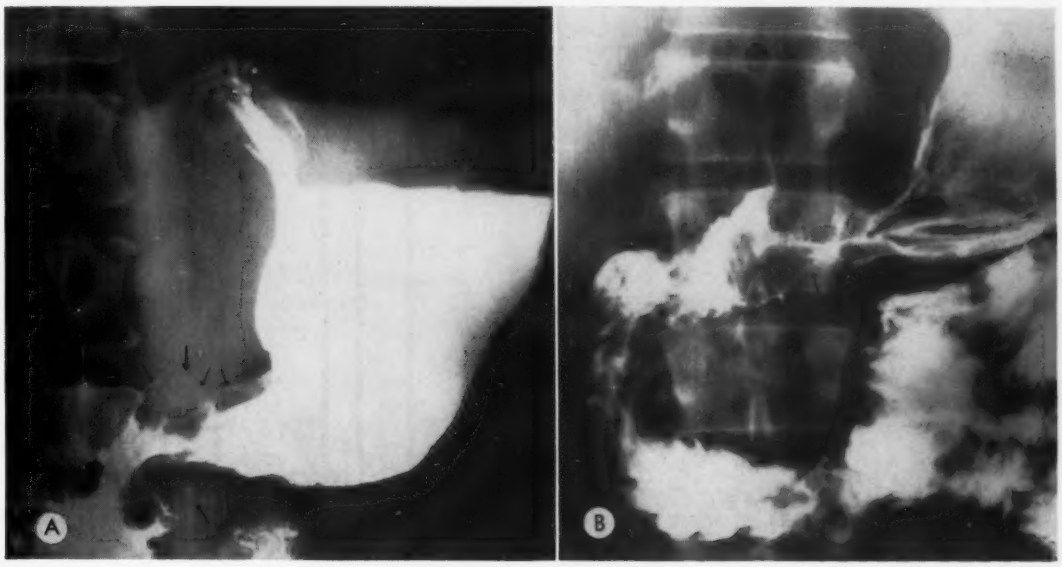

Fig. 6. (*A* and *B*) Large mucosal folds, twenty-five months after Billroth I operation with vagotomy, showing mild retention. Note the size and configuration of the folds proximal and distal to the stoma. Gastrointestinal series eleven days following resection revealed complete obstruction. Re-exploration, however, revealed a patent stoma. Fair clinical result.

factor in recurrent gastric ulceration.

Figure 9 demonstrates that obstruction and retention are far more frequently associated with enlarged than with normal mucosal folds, and it is interesting to note that these anatomic and physiologic postoperative abnormalities were found much more often in vagotomized patients. Obstruction and retention associated with normal mucosal folds were encountered only in patients with vagotomy. None of these signs were observed in one patient in whom a marginal ulcer was suspected. Following a transthoracic bilateral vagotomy, however, roentgenograms showed evidence of obstruction and retention.

Proximal Duodenum. Formation of a new duodenal bulb was noted at varying time intervals after operation, as shown in Table IV. The appearance of an intermittent pyloric action at the stoma was almost synchronous with the appearance of a newly formed bulb. The size of the new bulb appeared to increase as time elapsed after operation. Fifty per cent of the patients demonstrated very small bulbs, whereas 38 per cent of the patients showed bulbs approaching normal size, and 12 per cent demonstrated bulbs entirely normal in size and form (Fig. 10). It is likely that the small bulbs will eventually increase in size. Initial obstruction at the stoma did not appear to influence the size of the bulb. Some examinations indicated the possibility of

Fig. 7. Large mucosal folds, four months after Billroth I operation with vagotomy. Partial obstruction at the stoma with two large folds. Complete obstruction was demonstrated ten days following operation. Five months after operation, at pyloroplasty, a finger could be passed through the stoma, but a cuff of mucosa was noted at the anastomosis. No evidence of mechanical obstruction, but retention was noted after pyloroplasty. The patient is clinically well.

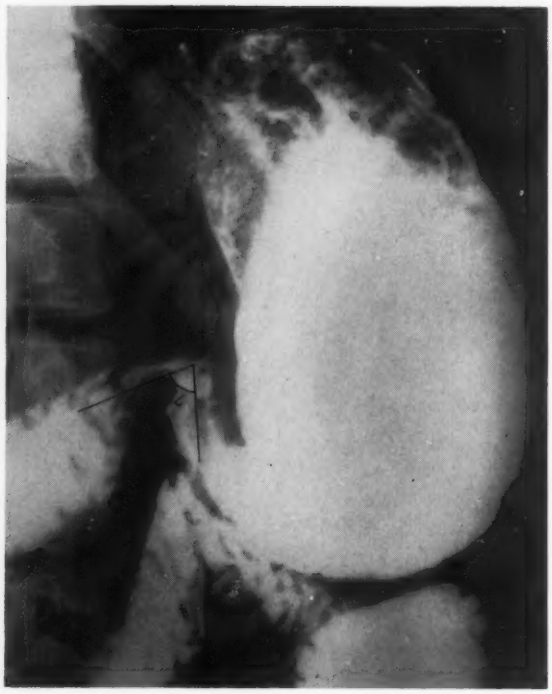

FIG. 8. Insufficient gastric resection resulting in acute angulation at the anastomosis and poor gastric emptying, two months after Billroth I operation with vagotomy. The patient is clinically well with only occasional complaints.

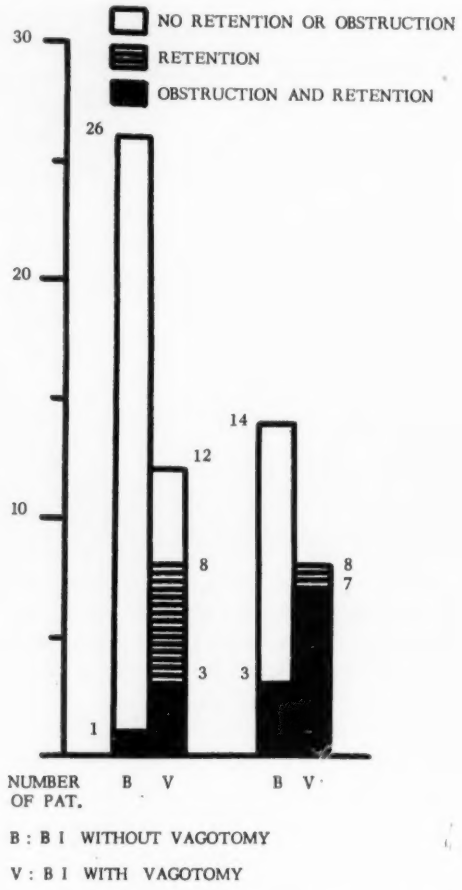

FIG. 9. Correlation of large and normal mucosal folds and of the obstruction and retention with the Billroth I type of operation (with and without vagotomy). The first two columns (B and V) refer to the normal mucosal folds and the second two columns (B and V) to the large mucosal folds.

gastric mucosal prolapse through the stoma.

Duodenum and Jejunum. In 41 of 60 patients, no dilatation of these intestinal segments could be found; the remaining 19 cases showed a questionable widening.

CLINICAL CORRELATION

Definite dumping was found in 9 of 60 cases (15 per cent). Six (10 per cent) additional patients complained of symptoms which suggested mild dumping. These cases were equally distributed between the groups with and without vagotomy. Nine months or later after operation, 3 of the 15 patients complained of dumping. Of the 60 patients, 9 demonstrated a shortened transit time of barium through the small bowel, and 3 of these 9 complained of dumping.

Dumping occurred in 5 of 11 patients with more than 75 per cent gastric resection, whereas it was noted in only 10 of 49 patients with less extensive resections. These data coincide with other studies which also showed an increased incidence

TABLE IV

DUODENAL BULB FORMATION

Months Postoperatively	1	2	3	4	5	6	7	9	12	>12
Duodenal Bulb Formation (per cent)	0	12.8	23.4	39.1	48.8	54.5	65.9	71.4	73.8	79.1

Table V

CLINICAL RESULT AT FOLLOW-UP EXAMINATION

Operative Procedure	Result			
	Well	Well with Occasional Symptoms	Fair	Poor
Billroth I Operation without Vagotomy	21 (52.5%)	14 (35.0%)	5 (12.5%)	
Billroth I Operation with Vagotomy	9 (45.0%)	6 (30.0%)	4 (20.0%)	1 (5.0%)
Total	30 (50.0%)	20 (33.3%)	9 (15.0%)	1 (1.7%)

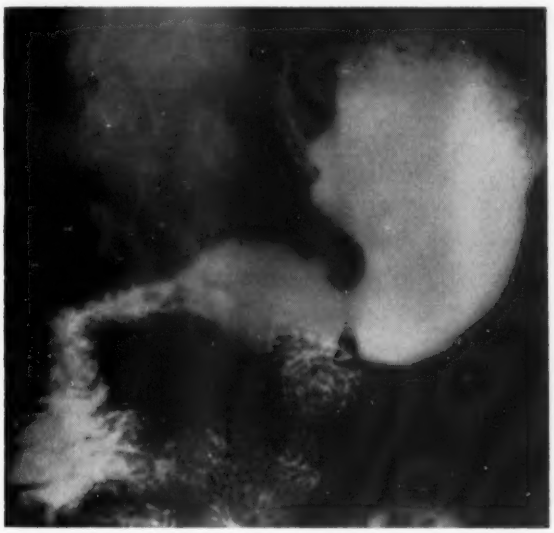

Fig. 10. Re-formed duodenal bulb, six and one-half months after Billroth I operation without vagotomy. The patient is clinically well.

of dumping with the more extensive gastric resections.[2] Age and sex did not influence the occurrence of dumping. No correlation of dumping with widening of the small intestine was found.

The results of postoperative follow-up examinations are shown in Table v.[4] The difference between the anatomic and functional state of the stomach is evident roentgenographically. The subjective symptoms in their distribution between the vagotomy and the nonvagotomy group are striking. Subjective well-being after vagotomy does thus not exclude the possibility of the presence of obstruction and retention as demonstrated roentgenographically.

CONCLUSIONS AND SUMMARY

Sixty cases of gastric resection following the Billroth I type of operation were studied roentgenographically at various time intervals after operation. The influence of additional bilateral vagotomy on the anatomic and physiologic state of the stomach is described. The correlation of the dumping syndrome and the roentgenographic appearance is discussed.

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THE ROENTGEN DIAGNOSIS AND MANAGEMENT OF PREPYLORIC NARROWINGS*

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OF THE three morphologic forms of gastric cancer, ulcerative, polypoid, and infiltrative, the latter is usually the hardest to detect roentgenologically. Once detected, it may also be most difficult to diagnose specifically because of its similarity to a number of benign lesions. Furthermore, while physicians are able to follow more or less standard treatment programs which eventually lead to an exact diagnosis for the polypoid and the ulcerative defects, no such systematic approach has been developed for gastric infiltrations which roentgenologically may be either benign or malignant.

Experience has shown that the roentgen appearance of many concentric prepyloric indurations or narrowings is consistent with both benign and malignant disease.[10] Sometimes, however, it is possible for the radiologist to make a specific diagnosis. For example, in a short, rigid narrowing with overhanging edges, mucosal destruction, and a palpable mass at fluoroscopy, the roentgen diagnosis of gastric cancer is specific and reliable (Fig. 1).[3] Similarly on the benign side, if there is a crescentic indentation at the bulb base with elongation of the pylorus and a diamond shaped central defect, and if, in addition, the prepyloric narrowing is relatively long with sloping borders on the gastric side, then the diagnosis of hypertrophic pyloric stenosis would dependably follow (Fig. 2).[2–14,15]

Because of the difficulty and confusion in the diagnosis and management of most of the small prepyloric infiltrations encountered roentgenologically, 23 histologically proved cases of such narrowings, 17 benign and 6 malignant, were reviewed. By a study of these cases it was hoped that diagnostic results might be improved or at least that some further insight into the problem presented would be gained. The 23 cases had no roentgen evidence of mass or ulceration, nor was there significant pyloric obstruction, retention or gastric decompensation. The basis for the selection of the material was primarily a roentgenologic one. For example, after one or more gastrointestinal series, no roentgen findings could be elicited that would reliably differentiate between cancer and benign disease. These 23 cases represent a commonly encountered problem in gastric roentgenology in our experience.

What actually happens when the roentgenologist reports an organic narrowing that he says may be either benign or malignant? Of course, there are additional methods of diagnosis, but they are usually not basically informative. Such, at least, was the experience with this material. Gastroscopy and cytology suffering obvious inherent limitations for the detection and diagnosis of lesions of this location and morphology, tend therefore to assume a secondary role, being of definitive value only when a positive report of cancer is obtained.

Needless to say, if the patient presents real symptoms that have no explanation other than the gastric lesion, then an operation is usually performed. The same holds if there is gastric decompensation and pyloric obstruction. Also, if the roentgenologist carefully emphasizes that he cannot fully exclude cancer, surgery would ordinarily be advised. However, if the complaints are mild, if they seem to respond to symptomatic treatment, and if, in addition, the roentgenologist favors even

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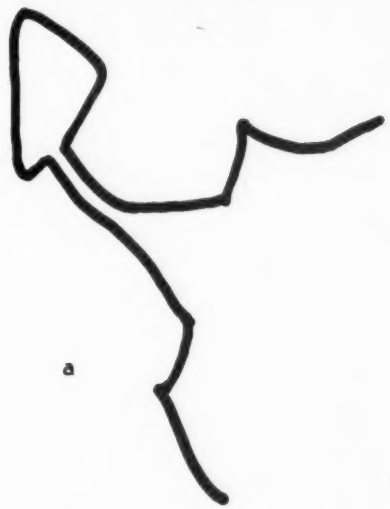

Fig. 1. (*A*) Annular prepyloric narrowing with abrupt, slightly overhanging edges, rigid walls, and mucosal destruction. Associated with a palpable mass, the appearance is pathognomonic of cancer. (*a*) Line drawing of *A*.

slightly the diagnosis of a benign process over cancer, operation would not be recommended or at most would not be very strongly urged. However, it is sometimes difficult to predict exactly what may occur in an individual situation. Apparently, many if not most of the patients with this

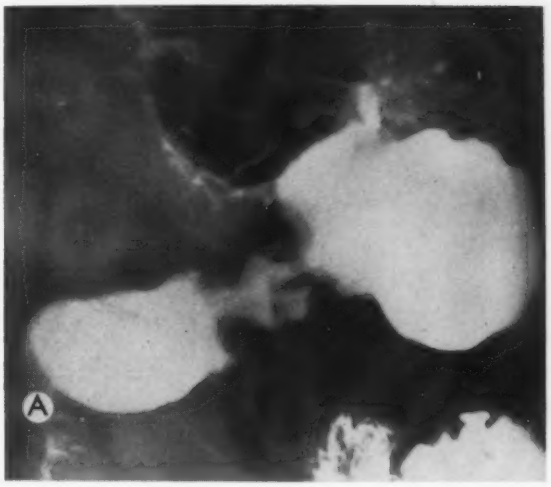

Fig. 2. (*A*) An appearance considered specific for the diagnosis of hypertrophic pyloric stenosis. (*a*) Line drawing of *A*.

type of defect eventually come to operation.

In a thorough evaluation of these pyloric narrowings, the roentgenologist faces difficulties in correlating his findings with

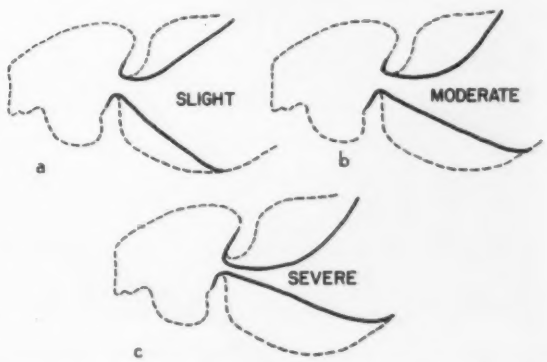

Fig. 3. (*a*) Slight degree of symmetric narrowing. (*b*) Moderate degree of symmetric narrowing. (*c*) Severe degree of symmetric narrowing.

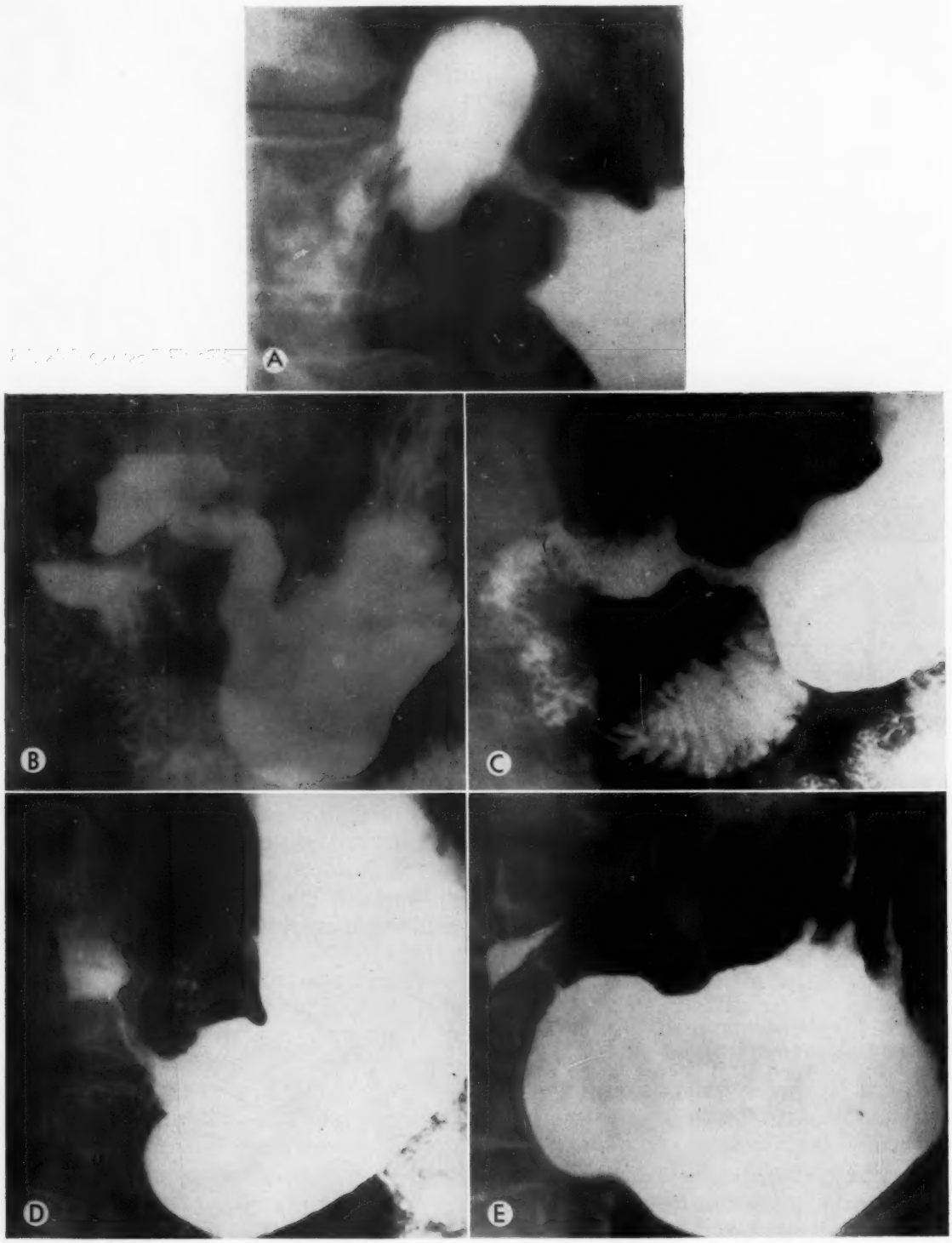

Fig. 4. (*A*, *B*, *C*, *D* and *E*) Cases of prepyloric narrowing due to cancer.

Fig. 4. (*a*, *b*, *c*, *d* and *e*) Line drawings of *A*, *B*, *C*, *D* and *E*, respectively.

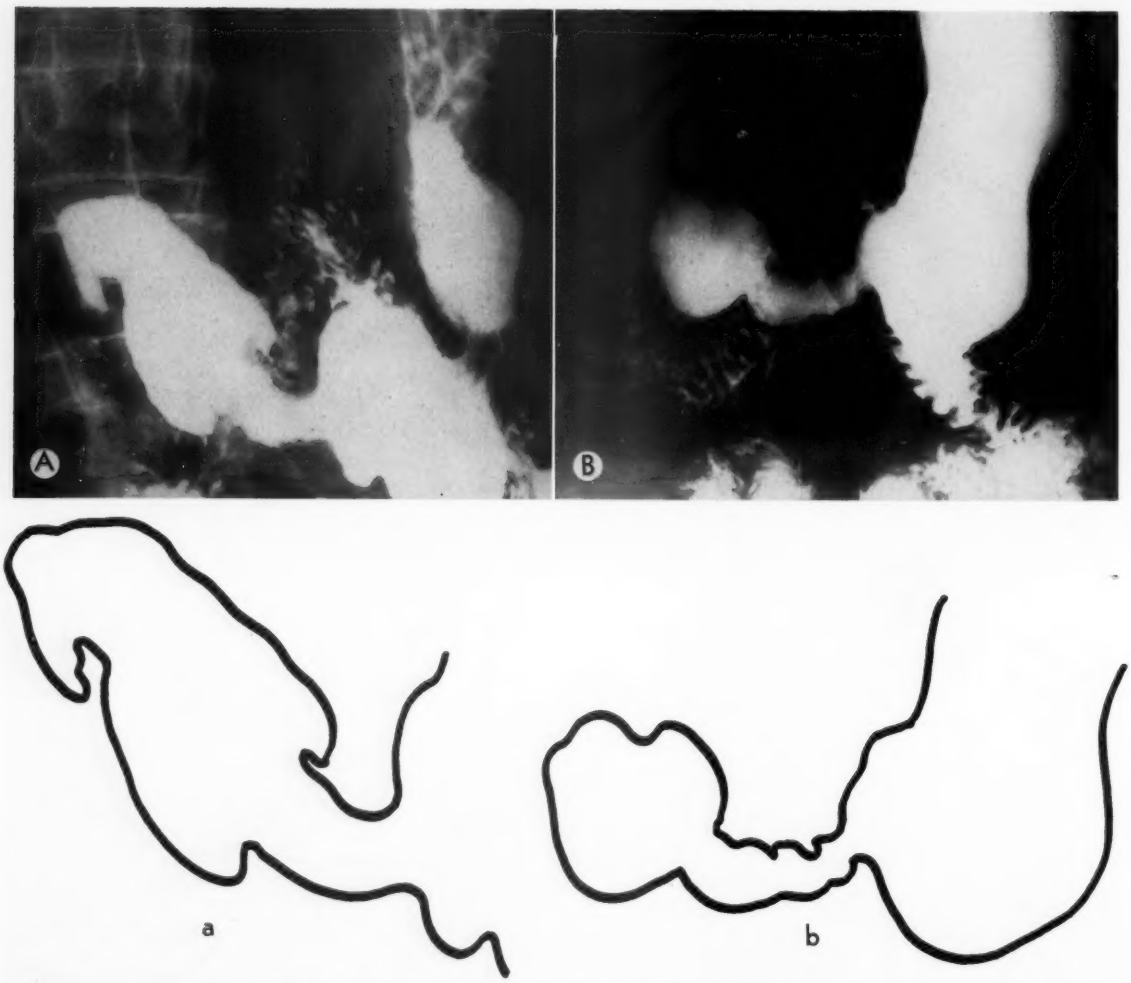

Fig. 5. Prepyloric narrowing due to lymphosarcoma. Case iv. (*A*) August 29, 1950. (*B*) October 23, 1952. (*a* and *b*) Line drawings of *A* and *B*, respectively.

those of the surgeon and the pathologist. It has now been adequately established[6,7,9,10,17] that palpation and inspection of the stomach by the surgeon, whether or not a gastrotomy is done, can be an unreliable and misleading way of arriving at a diagnosis. Evidently, procedures and attitudes in this regard have changed during the past decade.[11,13] Generally speaking, if supported by competent roentgen diagnosis as to the presence of an organic defect, resection is rewarded by the pathologist's confirmation of some type of abnormality even when palpation and inspection by the surgeon have been negative.

Although a closer correlation between the roentgenologic and pathologic opinions exists with these lesions than between those of the surgeon and the radiologist, there is nevertheless the occasional case in which the roentgenologist is certain a defect exists, but it is not confirmed by routine pathologic examination. Under such circumstances it is best that the pathologist be acquainted not only with the exact area under suspicion, but the type of defect under consideration as well. In spite of a negative routine pathologic report, roentgenologists usually will be correct in insisting that some type of organic abnormality is present if there is flattening of the pyloric "valves," persistent stiffening of a segment of the stomach wall, or elongation and narrowing of the pyloric canal.

To avoid the minor differences of opinion encountered pathologically in the benign

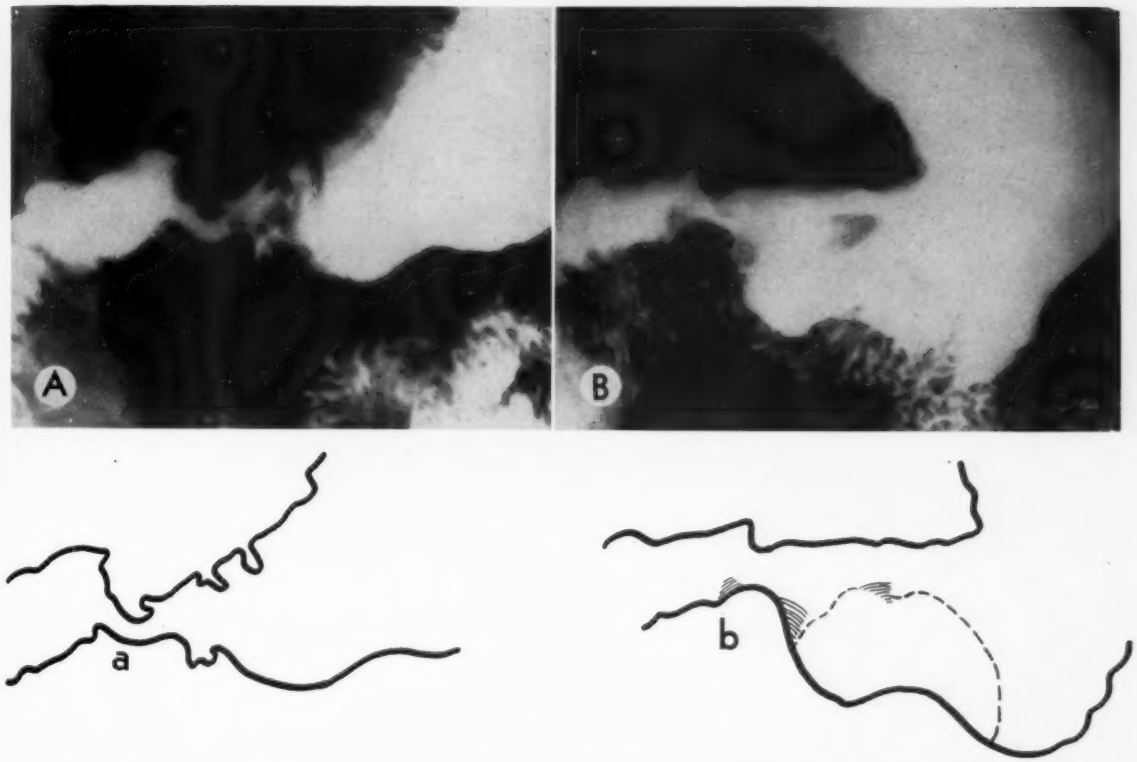

Fig. 6. Benign prepyloric narrowing associated with nearby gastric cancer. Case 1. (*A*) February 18, 1949. (*B*) April 13, 1954. (*a* and *b*) Line drawings of *A* and *B*, respectively.

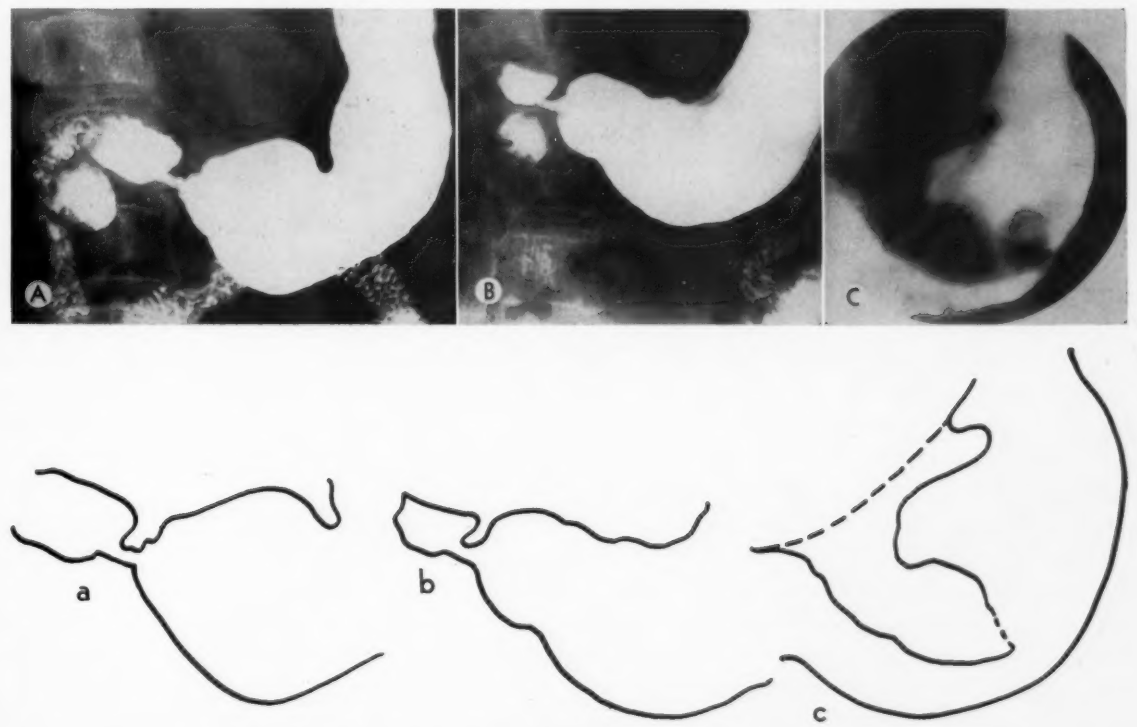

Fig. 7. Benign prepyloric narrowing associated with nearby gastric cancer. Case 11. (*A*) October 28, 1942. (*B* and *C*) June 2, 1946. (*a*, *b* and *c*) Line drawings of *A*, *B* and *C*, respectively.

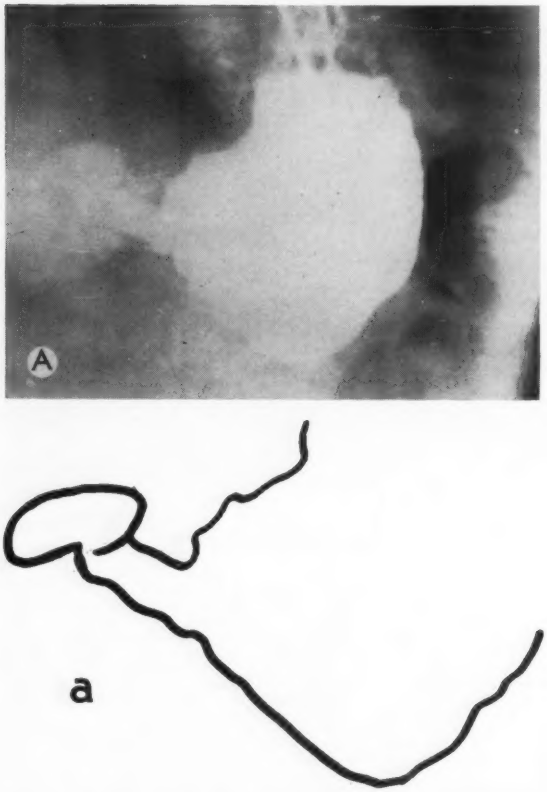

FIG. 8. Benign prepyloric narrowing associated with nearby gastric cancer. Case III. (*A*) October 14, 1946. (*a*) Line drawing of *A*.

lesions, all cases in this category which were considered to have either some type of benign disease or to be normal were grouped together. Actually, there were only a few which the pathologists considered to be normal. One pathologist's diagnosis might have been "no lesion," while another on the same material might have stated that there was "gastritis." This and differences of opinion of similar order indicate that the pathologic recognition of the normal stomach and some benign disorders such as gastritis, edema and muscle hypertrophy is rather uncertain. A better correlation between the roentgenologic and pathologic concepts of the normal and abnormal as regards the prepyloric region is, therefore, desirable.

The severity of the stenosis in both the benign and malignant groups was arbitrarily divided into three grades (Fig. 3*a*, *b* and *c*). If the gastric narrowing was less than 1 cm., it was called severe. If about equal to the width of the normal canal (1 cm.), it was classified as moderate and if greater than 1 cm., it was termed slight. Thirteen patients had moderate and 4 had minimal narrowing.

BENIGN STENOSES

The 17 patients with benign prepyloric constrictions (Fig. 9, 10 and 11) had an age range of forty-three to seventy-seven, with an average age of sixty-one. There were 6 males and 11 females. The number of gastrointestinal examinations on each patient varied from a single one on most to a total of 9 done over a nine year period on one individual. Six of the 17 were studied roentgenologically for one year or more.

Gastroscopy was performed on 12 patients. In 2 the examination was inadequate. Of the 10 gastroscopies which might be considered satisfactory, some type of an alteration was described in 7, but no specific diagnosis was made. In one a single ulcerative lesion was described on the anterior wall, but later the pathology report was that of miliary peptic ulcers, recently healed. A tumor was diagnosed in one instance and this, of course, was incorrect.

Cytologic studies were performed on only 2 patients and the report in one was a Class 1 and in the other Class 2. Many patients were seen prior to the use of present cytologic methods.

No cases of benign narrowings were associated with abnormalities of the gastrointestimal tract which might in any way be related. The stomach was very mildly decompensated in 2. In 13 the narrowing was constant and rigid roentgenologically, while in 4 it was thought to alter slightly in degree.

The pyloric canal was clearly evident in 7 cases, but the exact proximal border was not identifiable in 11 and it was indefinite in one. The length of the stenosed segment varied from 1 cm. to 3.5 cm. with an average of 2 cm. The proximal margin of the narrowing was smooth and conical in 13 cases; however, in 4 instances it was somewhat sharp and abrupt (Fig. 9*E*, Fig. 10,

D and *E* and Fig. 11*A*).

The status of the mucosa was evaluated, but detailed rugal studies were not available in all instances. The mucosa appeared normal in 8 and abnormal in 9. Three of the 9 showed a definitely disturbed gastric lining with a washed-out appearance. In 6 the pattern was only slightly altered.

The lesion was evaluated roentgenologically over a period of time in 3 instances. There was no apparent change in 2 patients who were followed for four and five years, respectively. The third showed an increase of 1.5 cm. in the length of the narrowed segment over a period of nine years.

The preoperative roentgen diagnosis in all was unequivocal as to the presence of an organic abnormality. The defect was always fully described and the report usually contained a statement that a benign process of this type could not be reliably distinguished from a malignant one by roentgen methods alone.

The surgeon's findings in regard to the prepyloric area were available in 14 cases. A neoplasm was apparently incorrectly diagnosed twice. Thickening of the area was reported 6 times. Completely negative findings were reported in 5. An equivocal change was reported once. In no case was an ulcer diagnosed.

The source of all the specimens for pathologic study was surgical. There were 5 with a full thickness biopsy. Two had mucosal biopsy and in 11 a gastric resection provided the material for histologic diagnosis.

The pathologic report of the 17 benign lesions varied. Nine were diagnosed as "gastritis," one as edema and 2 as showing some degree of hypertrophy of the pyloric muscle. Six exhibited microscopic erosions or ulcerations and one resembled syphilis. One showed "metaplasia" but 3 were called negative on routine study. Several of the cases had two or more of the pathologic conditions listed. Dr. Arthur G. Allen kindly reviewed the slides on selected cases.

Three patients were unique in that they developed a coexisting cancer and therefore their case histories are presented. Since several additional cancers of the stomach associated with a benign prepyloric narrowing have been encountered, the question arises whether this finding is of potential significance as a warning of gastric cancer development.

REPORT OF CASES

Case I. A.P., a sixty-five year old female, was first seen on February 1, 1949 with a complaint of "acid" stomach of fifteen years' duration. The physical examination was negative. On February 18, 1949 a gastrointestinal series was done at this institution and the prepyloric asymmetry was noted (Fig. 6*A*) but the roentgenologist was unable to state whether this was due to scarring by a previous peptic ulcer or to an infiltrative carcinoma. The patient was operated upon on February 23, 1949. At surgery no abnormality was noted. A gastrotomy was performed and a mucosal biopsy was taken. Pathologically, there was no evidence of a definite lesion. The patient was generally well for about five years when an episode of acute upper abdominal distress developed. The laboratory studies revealed anemia and the stools were positive for blood. A gastroscopy was performed on April 7, 1954 with inconclusive results. The patient was re-admitted and the gastroscopy was repeated. No cancer was found. A gastrointestinal series on April 13, 1954, however, revealed a polypoid and infiltrating tumor (Fig. 6*B*), in addition to the known pyloric deformity. Eight days later the patient was operated upon. A subtotal gastrectomy was done and the pathologic report by Dr. J. T. Godwin was that of carcinoma. The prepyloric area was free of tumor, but no detailed studies of this region were done in an attempt to explain the prepyloric defect present roentgenologically. The patient was last seen on May 22, 1957 at which time she was asymptomatic with no evidence of tumor.

Case II. M.M., a sixty-five year old female, was seen in May, 1942 complaining of epigastric pain of six months' duration. Her work-up revealed a secondary anemia. A gastrointestinal series on May 6, 1942 showed a narrowed prepyloric segment. On August 3, 1942 and again on October 28, 1942 (Fig. 7*A*) no change was seen and it was felt that the narrowing might be scarring caused by an old ulceration. After a four year interval because of a recur-

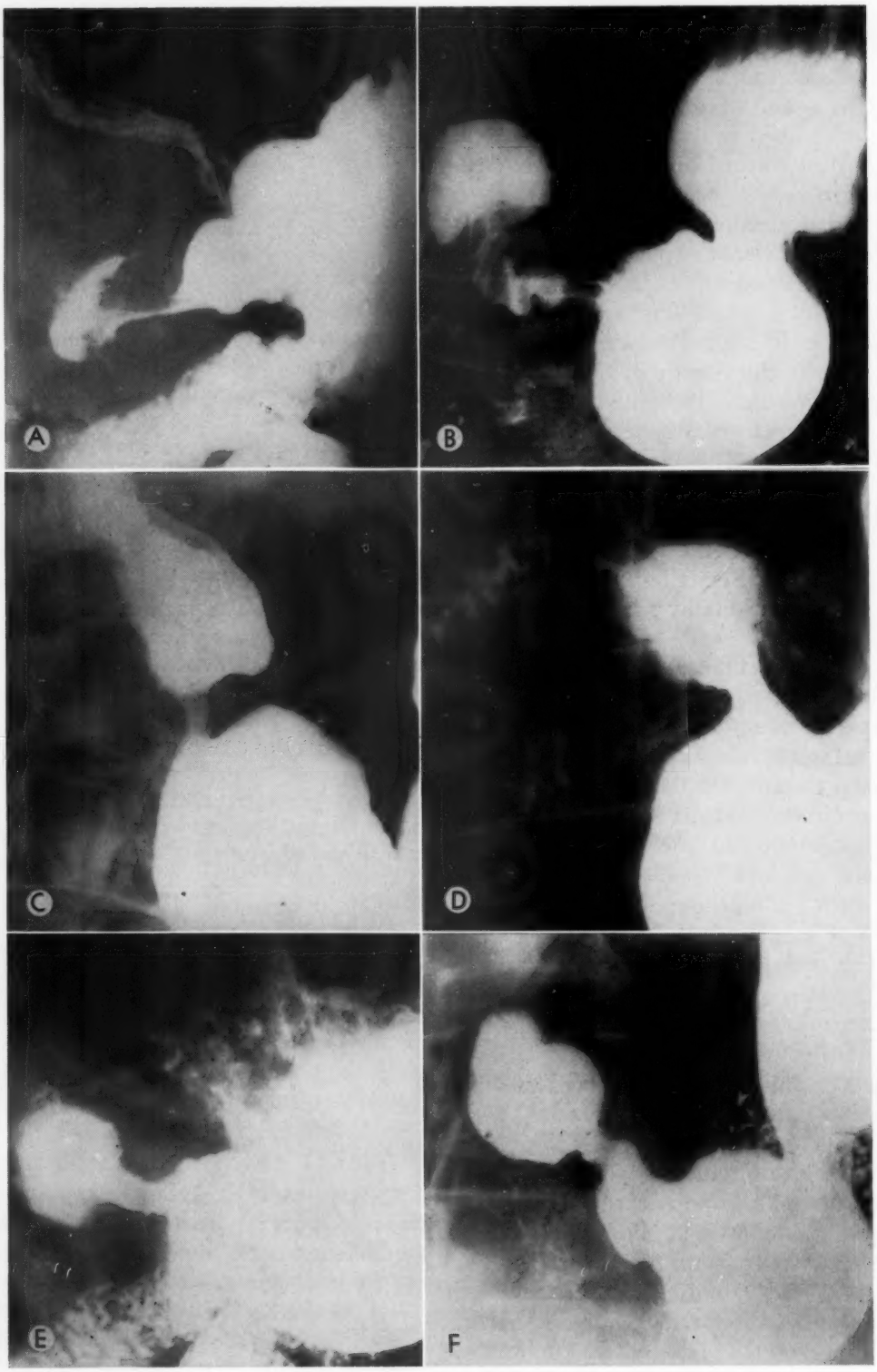

Fig. 9. (*A, B, C, D, E* and *F*) Prepyloric narrowing due to benign disease.

Fig. 9. (*a*, *b*, *c*, *d*, *e* and *f*) Line drawings of *A*, *B*, *C*, *D*, *E* and *F*, respectively.

rence of symptoms she was again examined roentgenologically (Fig. 7 *B* and *C*). It was now thought that a small gastric ulceration, possibly associated with a mucosal disturbance at the region of the incisura angularis was present. No mass was felt. Gastroscopy revealed nothing definite. There was no established diagnosis, but because of her definite secondary anemia and a return of weakness and anorexia and the development of the new roentgen findings surgery was performed. At operation a tumor about 5 cm. in size was found on the greater curvature side of the stomach in the antrum, but no attempt was made to evaluate the narrowed prepyloric area. The pathologic report of Dr. F. W. Stewart on the resected specimen was that of adenocarcinoma. There was considerable cellulitis of the stomach wall and atrophic gastritis was described. A free margin of normal mucosa was noted in the prepyloric region of the stomach with a zone of about 3 cm. between the distal end of the tumor and the pylorus. The patient was last seen on August 6, 1953 at which time she had no complaints and there was no evidence of disease.

Case III. E.J., a sixty-nine year old female, had a fluoroscopic gastric examination as part of a survey for asymptomatic adults in the Department of X-ray Diagnosis on October 14, 1946. A small filling defect was noted in the antrum of the stomach as well as a narrowed prepyloric segment (Fig. 8*A*). The roentgen examination was repeated on August 5, 1947 and it was thought that there was no interval change. Gastroscopy revealed carcinoma of the prepyloric region. On August 11, 1947 the patient was operated upon and two raised plaque-like lesions were found in the body of the stomach, one 2.5 cm. and the other 4 cm. in diameter. There were also tiny, mucosal seedlings in addition to the two large tumors.

Dr. Douglas Sunderland made a diagnosis of adenocarcinoma on each of the polypoid areas and a diagnosis of carcinoma *in situ* on the mucosal foci. Dr. Arthur G. Allen recently reviewed the routine slides on this case and said that the prepyloric region itself showed nothing to explain the persistent prepyloric narrowing. The patient was last seen on July 10, 1957. She was well and had no evidence of tumor.

MALIGNANT NARROWINGS

There were 6 examples of malignant infiltration in the prepyloric region. The ages varied from fifty-five to seventy-three with an average age of sixty-three. Four were males and 2 were females. The roentgen coverage consisted of one or two studies except for one individual who had several gastrointestinal series over three and one-half years. Except for this last case all were operated upon within a month after the first gastrointestinal examination.

Gastroscopy was done on 3 patients. In one it was considered inadequate. A diagnosis of a 5 mm. "ulcer" was made in another. This patient had lymphosarcoma and later the pathologist made no mention of an ulceration (Case IV). Cell washings were carried out on 2 patients and in each there were 3 specimens. All were reported negative for malignant cells.

One of the 6 cancer cases showed very slight gastric decompensation roentgenologically and none presented an ulceration or palpable mass. The narrowing was always constant, being minimal in degree in one, moderate in 3 and severe in 2. The pyloric canal was identifiable in 3 patients but not in the others. The length of the stenosed segment varied from 2 to 6 cm. with an average of 3.2 cm. The proximal margin was smooth and conical in 4 cases and somewhat sharp and abrupt in 2. The mucosa appeared normal in one patient but in the rest the pattern seemed abnormal, being definitely washed out in 4 and slightly disturbed in one.

There were 2 cancer cases that presented a faint double density at the proximal margin of the lesion (Fig. 4, *C* and *D*). It appears now that this feature may favor a diagnosis of cancer inasmuch as this double edge pattern was not encountered in any of the benign narrowings.

The surgical opinions at the time of the operation varied. A carcinoma was reported in one case, a mass in another and a "thickening" was described on three occasions.

The source of the specimen was from a gastric resection in 5 cases and a postmortem examination in one. The pathologic report was that of carcinoma in 3,

"superficial" carcinoma in one, and leukemic infiltration in another (Fig. 4*B*). Lymphosarcoma was present in the sixth case (Fig. 5, *A* and *B*) and because of the unusual features, this case history is also included.

REPORT OF A CASE

Case IV. P.P., a seventy-six year old male, was operated upon on March 27, 1946 for a skin tumor which proved to be a malignant melanoma. Beginning in January, 1949 he complained of recurrent gastric distress with some weight loss. From January 27, 1949 to October 23, 1952 this patient had 9 roentgenologic examinations of the upper gastrointestinal tract. The first 3 were carried out elsewhere, but 6 were done in our department. During this period some progression of the disease in the prepyloric area was noted, the length of the narrowing increasing from 4 to 6 cm. and the degree of stenosis changing from minimal to moderate. However, the prepyloric abnormality was believed to be most likely caused by an old inflammatory process (Fig. 5, *A* and *B*). The gastroscopist diagnosed a shallow 5 mm. ulceration on the lesser curvature of the stomach which was thought possibly to be due to metastatic melanoma. Just prior to surgery, which was performed on October 26, 1952, a cytologic study was reported as Class 4. At operation the surgeon described thickening of the mucosa. Biopsies were taken, but these were reported as not diagnostic. However, a malignant lesion was suspected by the surgeon and a subtotal gastrectomy was performed. The pathologic diagnosis by Dr. F. W. Stewart was that of gastric lymphosarcoma. The patient was last seen on May 27, 1957 at which time there was no evidence of disease and he was asymptomatic.

DISCUSSION

When the findings in the two groups are carefully compared, it is evident that little or no reliable roentgen information emerges that permits a specific roentgen diagnosis to be made. In the benign cases the narrowing appeared to be somewhat more severe. There was more mucosal disturbance in the malignant cases. There were asymmetric stenoses in both categories. Obviously, none of these findings nor any combination of them permits a specific diagnosis. The only diagnostic point elicited of possible significance was the faint, double-contoured margin proximally. We interpret this as a function of an abrupt and sharp border between cancerous and normal tissue, a sort of a precursory finding to the overhanging edge so commonly encountered in annular cancers of the gastrointestinal tract.

The various diseases diagnosed histologically in these cases more or less reflect the range of benign and malignant lesions that one needs to consider as causes for the type of prepyloric narrowing being discussed.[1,10] However, the emphasis given to adhesions as an explanation for prepyloric constriction by others[10,12] found no support in this study. Neither did spasm seem a troublesome feature.[11] Among the more unusual causes of prepyloric narrowing are lues (or tuberculosis), leukemic infiltration and lymphosarcoma. There was a high proportion of descriptive diagnoses such as edema,[19] gastritis,[20] hypertrophy of the muscle, superficial erosions and metaplasia. Although segmental enteritis and allied conditions may affect the prepyloric region of the stomach,[4,16] these diseases apparently always show additional areas of gastrointestinal tract involvement beyond the stomach. Usually, cases of ingestion of acids or caustics are evident from the history and the multiple sites of damage inflicted by these noxious materials.[5] Syphilitic or tuberculous[8] infection localized to the prepyloric region and presenting the sort of lesion under consideration would appear to be extremely rare today.

THE MANAGEMENT OF PREPYLORIC NARROWINGS

In order to evaluate the attitudes and approach commonly in practice, 3 experienced roentgenologists were shown the 6 cases of malignant narrowing. The examiners were told to report either benign, malignant, or "don't know" as their experience dictated. Obviously, the correct diagnosis to have been made on each case

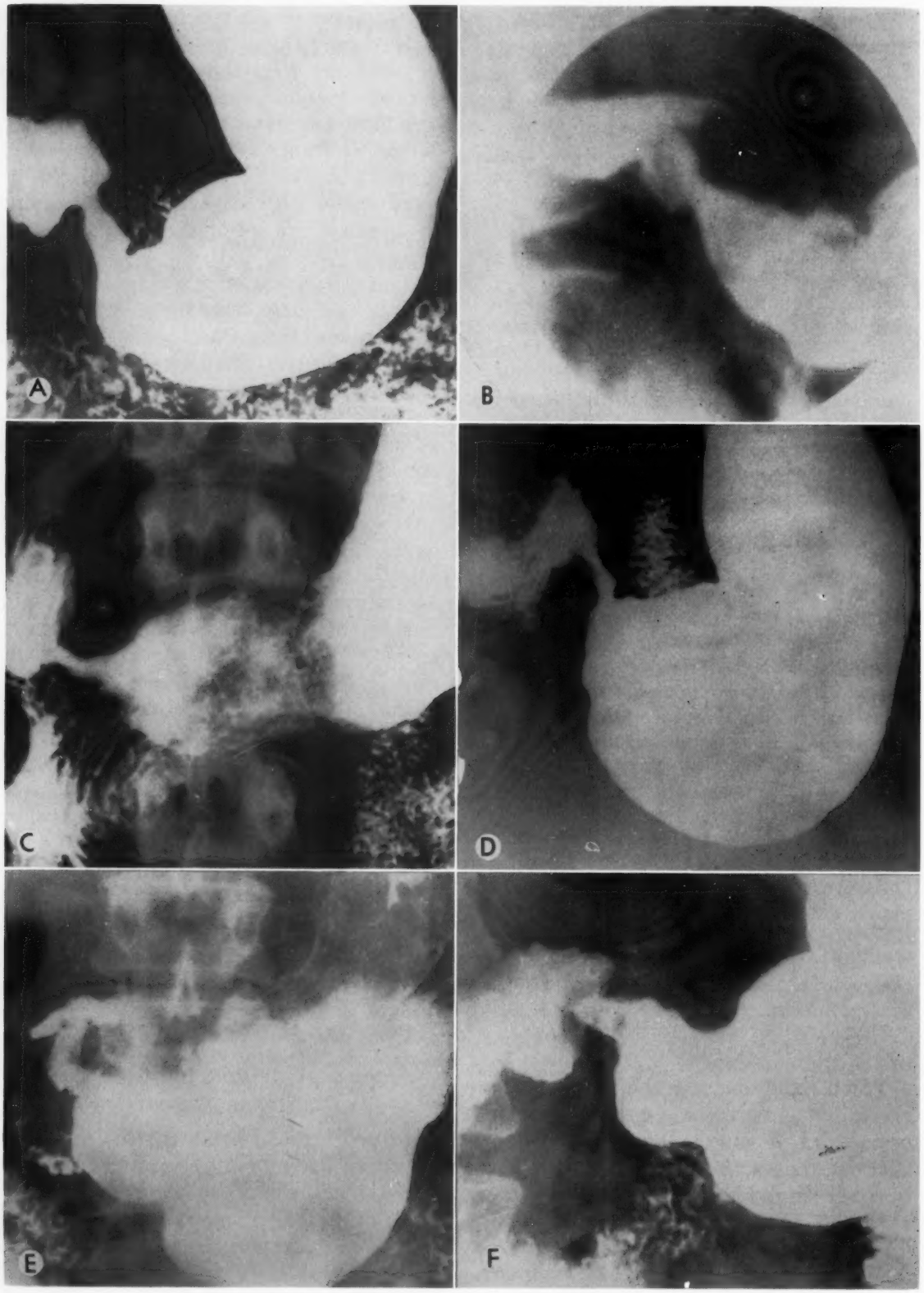

Fig. 10. (*A*, *B*, *C*, *D*, *E* and *F*) Prepyloric narrowing due to benign disease.

Fig. 10. (*a*, *b*, *c*, *d*, *e* and *f*) Line drawings of *A*, *B*, *C*, *D*, *E* and *F*, respectively.

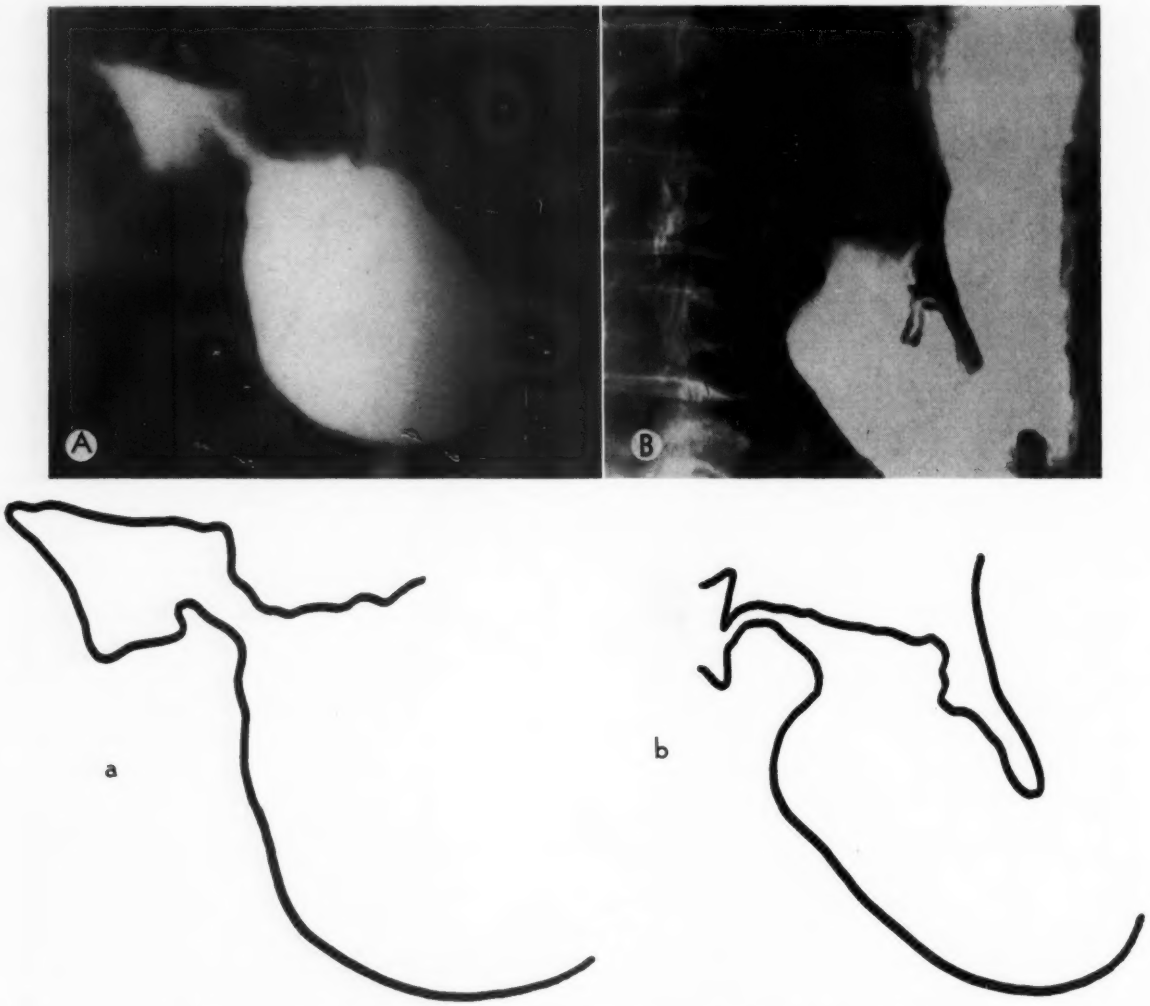

Fig. 11. (*A* and *B*) Prepyloric narrowing due to benign disease. (*a* and *b*) Line drawings of *A* and *B*, respectively.

would have been "don't know" or "impossible to tell." Only one was diagnosed by all 3 examiners as malignant, but later none could offer reliable evidence upon which this opinion was based. Several were called benign and only in a few instances did these roentgenologists admit that they did not know or were unable to tell reliably what the diagnosis was.

The symptoms in these patients varied from none to fairly typical, ulcer-like pains. In between these two extremes, one or more of the group had complaints such as nausea, vomiting or melena. It appears, however, that those patients presenting peptic ulcer symptomatology, *i.e.*, recurring, postprandial substernal burning pain, relieved by milk or alkali, in almost every instance had a definite diagnosis made when the histologic study was completed. This comprised scarring in the majority, but also included one case each of superficial adenocarcinoma, lymphosarcoma and probable gastric syphilis. Those patients with nondescript symptomatology often had a final pathologic diagnosis which was equally nondescript, *e.g.*, chronic gastritis, hypertrophy of muscle, or edema, but which also proved to be cancer in 3. The duration of symptoms seemed

completely unrelated to the final pathologic diagnosis. The same may be said for the degree of weight loss.

The gross findings at operation were significant in this respect. When the stomach and duodenum were described as normal or as negative, or when only scarring was encountered, the final pathologic diagnosis was benign in every instance. When, however, there was gross evidence of thickening or induration, and, of course, when there was a palpable mass, the final diagnosis was as likely to be cancer as not.

It would appear therefore that a reasonable approach to the treatment of lesions exemplified by these patients might be as follows: When the radiologist is satisfied that this particular type of prepyloric narrowing is present after at least two separate studies, then the patient should be prepared for laparotomy without undue delay. Gastroscopy and cytologic studies can be undertaken during this period of preparation, if desired, for what help they might contribute. A gastric analysis with histamine stimulation should also be done. If the surgeon finds the stomach and duodenum to be entirely normal, a full thickness biopsy of the gastric wall in the immediate prepyloric segment corresponding to the area of roentgenologic abnormality should be taken. Inspection and palpation of the interior of the stomach can be carried out prior to closure of the gastrotomy. If no unsuspected lesions are thus discovered, the abdomen should be closed without gastric resection if stenosis seems to be absent. The full thickness biopsy of each nonresected case should be studied and, if possible, reported before the patient's discharge from the hospital. If, on the other hand, there is prepyloric thickening or induration, and, of course, if a mass is palpable, then gastric resection should be undertaken forthwith.

With such a plan benign lesions would probably be resected as often as malignant ones, but those patients who, on the basis of the data derived from this study, are least likely to have cancer would be spared the morbidity, mortality, and postoperative functional disorders of gastric resection. Actually, more information as to the subsequent course of these patients is needed then we now have available in order to determine how well those not resected were able to get along with their narrowed prepyloric segment.

Eight of the patients in this series had gastric analysis recorded, of which only 2 showed achlorhydria. On the basis of the gastric analysis mentioned above, gastric resection might reasonably be performed on any patient with achlorhydria because such a prepyloric narrowing presumably has greater chance of being malignant in the achlorhydric than in the patient with normal gastric acidity. Whether or not this will prove to be the eventual situation, one surmises that an anacidic stomach is a potentially cancerous stomach at best and that the patient's interest would be served by prophylactic resection at the time the abdomen is open and when he has already been prepared for resection.

SUMMARY

1. The results of this study of 23 histologically proved and roentgenologically similar prepyloric narrowings, 17 benign and 6 malignant, indicate that there is a definite inherent limitation in the roentgen diagnosis of lesions of this type.

2. Experienced radiologists when tested with some of this material offered diagnoses that were largely incorrect and not based upon factual knowledge.

3. The only roentgen appearance of possible diagnostic significance was the faint, double edge or margin found in 2 of the 6 cancer cases.

4. These prepyloric narrowings constitute one type of gastric lesion for which cytologic help would be especially valuable.

5. When the surgeon described the stomach as normal or when only scarring was present, the final pathologic diagnosis was always benign. When some degree of thickening or a mass was noted, the final

diagnosis was as likely to be cancer as not.

6. Present day surgical diagnosis entails gastrotomy, inspection, and full thickness biopsy in all cases that do not present typical induration or mass.

7. Perhaps all of these patients showing achlorhydria should be resected.

8. A better correlation between the roentgenologic and pathologic findings in the lesions being discussed is needed, but apparently the pathologic definition of the normal and a number of benign conditions in the prepyloric region is not standardized or always consistent.

9. Follow-up studies are indicated to determine fully the eventual course of the benign prepyloric narrowings unassociated with gastric retention and decompensation that are not treated surgically.

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Vol. 81, No. 4

SPLENIC INDENTATION OF THE GASTRIC FUNDUS RESEMBLING GASTRIC NEOPLASM*

REPORT OF TWO CASES

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THE stomach, being a hollow viscus, centrally placed in the upper abdomen is in natural relationship to the liver, spleen, pancreas, and colon. It is not surprising that disease in these adjacent organs can and often does produce roentgenographically demonstrable displacement or distortion of the stomach. Indeed, such distortions are often very helpful in the differential diagnosis of the offending pathology. Usually it is not difficult to separate true intrinsic deformity of the stomach from extrinsic pressure or distortion. Gross displacement of the stomach by pancreatic tumors or cysts or other expanding retroperitoneal lesions is well documented. Less commonly, tumors or inflammatory conditions of the left lobe of the liver have been observed to produce irregularities of the lesser curvature of the stomach resembling neoplasm. The grossly enlarged and diseased spleen is frequently the cause of medial displacement, and occasionally the normal spleen will produce a smooth indentation of the lateral margin of the stomach in the region of the cardia.

Recent experience with 2 cases in which a normal spleen was found to be responsible for the production of a persistent filling defect of the fundus of the stomach resembling polypoid gastric neoplasm prompted this report. Although this condition may have been observed by others, we are unable to find it reported in the literature. In each of these cases, the filling defect was identified on upper gastrointestinal roentgenograms and was confirmed by one or more repeat examinations. In each instance, the presence of this gastric defect was felt to be unrelated to the patient's symptomatology, but exploration was felt to be mandatory on the basis of the roentgenographic findings.

REPORT OF CASES

Case 1. Mrs. B.S., a fifty year old white female, was admitted to the United States Naval Hospital, Bethesda, Maryland on November 15, 1955, for investigation of complaints of intermittent episodes of mild midabdominal pain, distention, belching, nausea and occasional vomiting. These episodes usually lasted two to three days, subsiding spontaneously. They had been occurring over a period of years without significant change. Complete roentgenographic studies of the gastrointestinal tract had been made in 1953 for these same complaints and were reported to be negative. Past history was noncontributory. No significant abnormalities were found on physical examination. Additional studies including complete blood cell count, urine analysis, serology, liver function studies, stool examination, electrocardiography, cholecystography, intravenous pyelography and sigmoidoscopy were normal. Histamine gastric analysis revealed a high free hydrochloric acid. Gastroscopic examination showed hypertrophic gastritis. Upper gastrointestinal roentgenographic studies showed a persistent filling defect along the greater curvature of the stomach slightly below the fundus (Fig. 1 and 2). The exact nature of this defect could not be determined, but it did not strongly suggest a malignant lesion. Since the patient had become and remained asymptomatic, she was discharged with instructions to return in three months for repeat examination. She returned on February 2, 1956, still essentially asymptomatic. Upper gastrointestinal series again showed the filling defect in the fundus of the stomach along the greater curvature which

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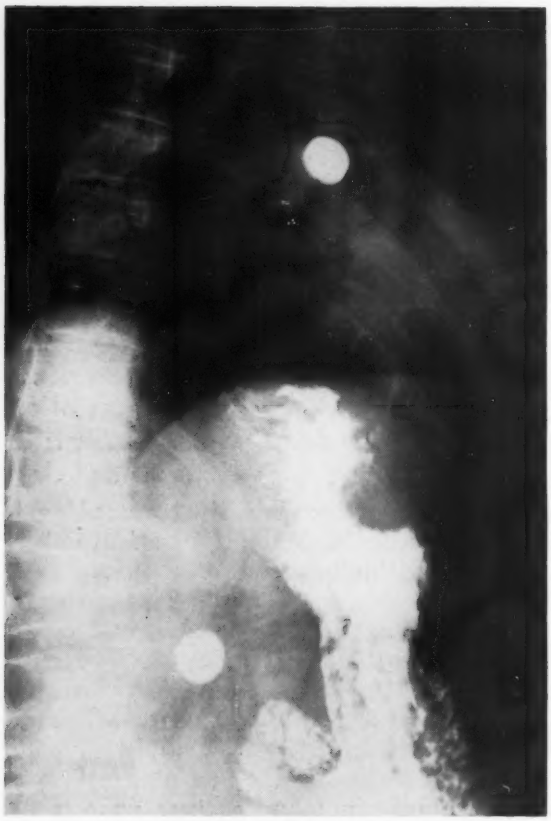

Fig. 1. Case 1. Right anterior oblique roentgenogram illustrating filling defect in gastric fundus produced by adjacent normal spleen.

fairly duplicated the findings of three months previously. The indentation appeared to be slightly larger and the mucosal pattern overlying it was considered somewhat more irregular.

It was felt that this persistent defect most probably represented a benign gastric tumor, perhaps a leiomyoma, and exploration was carried out. At operation, the entire stomach was carefully examined visually and by palpation and no intrinsic abnormality could be found. The superior tip of the spleen, which was grossly normal, was noted to be in intimate and persistent contact with the greater curvature of the stomach at approximately the level of the filling defect as seen in the roentgenograms. It was felt that the splenic tip had undoubtedly caused the roentgenographic abnormality. Thorough examination failed to reveal any other significant intra-abdominal pathology. After an incidental appendectomy, the abdomen was closed. The patient had a completely uneventful postoperative convalescence.

Case II. P. S., a twenty-year old white male hospital corpsman, was admitted to the United States Naval Hospital, Bethesda, Maryland on December 9, 1957, for investigation of complaints of recurrent episodes of nausea, vomiting and sharp epigastric burning pain. The most recent episode had begun five days prior to admission but past history revealed that the patient had had vague abdominal complaints since early childhood. In the six months immediately prior to admission, he had had upper gastrointestinal roentgenographic studies for suspected ulcer disease. These were reported to be negative. The patient was a heavy smoker and in the habit of consuming large amounts of alcohol until five months prior to the admission when he reportedly stopped drinking.

Physical examination was entirely normal except for marked tenderness to palpation in the midepigastrium associated with moderate voluntary upper abdominal guarding. Laboratory studies which included blood cell counts, sedimentation rate, urine analysis, serology, serum bilirubin, amylase, sodium, chlorides, potassium and porphyrin determinations were all within normal limits. Three separate upper gastrointestinal examinations with air contrast showed a persistent irregular filling

Fig. 2. Case 1. Spot roentgenogram demonstrating polypoid character of roentgenographic defect.

defect of the fundus of the stomach, most suggestive of a polypoid lesion (Fig. 3 and 4). Gastroscopy was carried out and no lesion was seen; however, the area in question could not be satisfactorily visualized.

The patient was initially treated with an ulcer regimen and rapidly became asymptomatic. Because of the persistent roentgenographic defect in the stomach, exploratory laparotomy was advised. On January 7, 1958, exploration with gastrotomy was carried out. With the exception of a moderate degree of hypertrophic gastritis, no intrinsic lesion of the stomach could be found. The superior tip of the spleen was in immediate relation to the greater curvature of the fundus of the stomach and was noted to indent the gastric wall. The spleen was freely movable and grossly normal in size, shape and consistency. There was no question but that the splenic indentation of the gastric wall was the explanation for the roentgenographic findings. The gastrotomy was then closed and examination of the other intra-abdominal viscera was carried out. No significant pathology being found, the abdomen was closed and the patient made a totally uneventful convalescence.

Fig. 3. Case II. Posteroanterior roentgenogram illustrating indentation of gastric fundus by superior tip of the spleen.

Fig. 4. Case II. Spot roentgenogram showing persistent defect in the gastric fundus.

DISCUSSION

These 2 cases have several distinct similarities. Each had been hospitalized for investigation of rather vague upper gastrointestinal complaints of a recurrent nature. Upper gastrointestinal roentgenograms were obtained in each case with the object of ruling out an organic explanation for these symptoms, rather than to confirm the presence of some clinically suspected entity. In neither case did the roentgenographic findings of a persistent filling defect of the fundus of the stomach seem to relate to the symptoms. In each case, the roentgenographic defect was consistently demonstrable on multiple examinations. The character of the roentgenographic defect was similar in both cases in that it most strongly suggested the presence of an intramural polypoid lesion of the gastric wall. The possibility of indentation by adjacent viscera was strongly considered by the roentgenologist and though his examination was hampered by the fact that these defects were high under the left costal margin and thus could not be fluoroscopically manipulated satisfactorily, his final conclusion in each case was that of intrinsic

gastric pathology. Gastroscopy was done in both instances and in neither was any localized lesion noted. However, the negative findings could not be given great significance as the gastroscopist freely admitted that the area in question could not be satisfactorily visualized because of its position high in the fundus. Clinically, the problem resolved itself in each case to the presence of a persistent filling defect of the stomach as shown on roentgenograms, not well related to symptomatology and not definitively diagnosed by any laboratory or other diagnostic aid. It should be said in regard to the second case, with the experience of the first case in mind, that the possibility of splenic indentation was suggested preoperatively. In spite of this suspicion, intragastric pathology could not be satisfactorily ruled out without exploration. The spleen in each case was normal in size, shape and consistency. The indentation of the gastric wall by the superior tip of the spleen was clearly seen in both instances and related well to the roentgenographic defects.

The fact that the superior tip of the spleen can on occasion cause a recognizable indentation in the gastric wall is in itself not surprising. The possibility that a defect so caused may be a persistent finding on repeated roentgenograms is not well recognized. Understandably such a defect, which in the experience of our 2 cases defied all efforts at more accurate definition, can easily be confused with true intrinsic gastric pathology. The repeated roentgenographic studies, in which special attention, techniques, and position were used to investigate the area in question, resulted only in confirmation of the persistence of the original defect. It is questionable whether other diagnostic studies such as pneumoperitoneum or splenoportography would be helpful in clearly differentiating this indentation of the gastric wall by the superior tip of the spleen from true intrinsic gastric pathology. This condition, which must be considered as a variant of the position and relation of a normal spleen to the stomach, can easily be mistaken for and clinically be indistinguishable from other more serious gastric pathology and as such seems worthy of mention.

SUMMARY

Two cases of indentation of the wall of the gastric fundus by the superior tip of the spleen are presented. The defects so produced were clinically and roentgenographically indistinguishable from those of true intrinsic gastric neoplasms. We are unable to find this condition described in the literature and believe it should be recognized and considered in the differential diagnosis of roentgenographic filling defects of the gastric fundus.

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EARLY AND LATE ROENTGENOLOGIC FINDINGS IN CORROSIVE GASTRITIS*

REPORT OF A CASE

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REPORTS on the effect of corrosive chemicals upon the gastric mucosa and its sequelae have been rather infrequent. In 1948, Gray and Holmes[4] reviewed the literature on corrosive gastritis and found 139 cases. They believe that corrosive gastritis occurs more frequently than is suggested by the above figure. Late effects of ingestion of corrosive agents upon the stomach are not well appreciated for several reasons. Some of these patients die shortly after the accident from perforation, gangrene or shock and never come to the attention of the clinician. Others may run an asymptomatic course for a longer period. After a number of years, they present signs and symptoms of pyloric obstruction which may be misdiagnosed as being secondary to chronic peptic ulcer or annular carcinoma of the antrum.[3] Loygue and Gérard[8] in a recent review of the literature were able to find about 30 cases of corrosive gastritis reported since 1948 to which they added 3 cases of their own. This brings the number of reported cases of pyloric obstruction secondary to ingestion of corrosive agents to about 170. It is noteworthy that all of the reported cases of corrosive gastritis have invariably been examined roentgenologically only after development of full blown pyloric obstruction. With the exception of a single illustration presented by Hodges and Rubin,[6] we have been unable to find a bona fide case of corrosive gastritis documented roentgenologically during the early stage of edema and acute inflammatory period. In our case, however, we have had an opportunity to study the stomach during the initial acute stage, and over a ten month follow-up period. This enabled us to observe the sequence of events leading to pyloric obstruction. For this reason, we believe that the case presents features of interest both clinically and roentgenologically.

REPORT OF A CASE

The patient N.M. (Nemazee Hospital No. 4049), a thirty-one year old married white man, was admitted to the hospital on November 19, 1956. He had drunk about 60 cc. of concentrated hydrochloric acid approximately forty hours prior to admission.

Present Illness. The patient was well until forty hours prior to admission. At this time, while he was entertaining guests in his home, he left the room to get a drink of Sherbat (a Persian mixture of sweet water seasoned by various fruit juices). Apparently, he mistook a bottle of hydrochloric acid on the shelf for a bottle of Sherbat. He poured an estimated 60 cc. of it into his glass, filling the remainder with water. He reported that he drank the mixture so rapidly that he did not realize the nature of the drink until the very end when he felt a severe burning sensation at the base of his tongue and throat. He then realized his mistake and immediately drank several glasses of water. One hour later, he vomited a quantity of watery material in which no blood was present. At approximately the same time, he was given a sodium bicarbonate solution of unknown strength, and milk, both of which he vomited promptly. About two hours after ingestion of the acid, vomiting recurred, and at this time, the vomitus was bloody. He was then admitted to another hospital where he received various vitamin injections and bismuth powder. The vomiting persisted intermittently and he gradually developed generalized pain across the upper abdomen. He was therefore transferred to our hospital. There was nothing contributory in the past history, the family history or the review of the systems.

Physical Examination. The patient was a

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Fig. 1. A right anterior oblique roentgenogram of the stomach (November 26, 1956). Note the polypoid filling defects in the antrum and the prepyloric region.

well developed, well nourished man who appeared in moderate distress. The vital signs were normal. There was generalized tenderness across the upper abdomen and evidence of a moderate degree of dehydration.

Laboratory and Roentgen Findings. The white blood cell count on admission was 29,000/cu. mm. After hydration by parenteral infusion of 5 per cent glucose with saline solution, the white blood cell count dropped to 9,500/cu. mm. Since the possibility of intestinal perforation secondary to acute corrosive gastritis was considered, an upright roentgenogram of the abdomen was obtained. This showed no evidence of free air in the peritoneal cavity. On the seventh hospital day vomiting ceased, abdominal pain diminished, and vital signs reverted to normal. A roentgen examination of the gastrointestinal tract was made. This showed that the esophagus and proximal two-thirds of the stomach were normal. The distal third of the stomach, especially the prepyloric region, showed peculiar filling defects (Fig. 1), which could almost be mistaken for a polypoid carcinoma at fluoroscopy. However, study of the spot roentgenograms, which were obtained after gentle pressure over the prepyloric region, proved these filling defects to represent large edematous mucosal folds. No definite pyloric obstruction was demonstrated at this time.

Subsequent Course. The patient was treated conservatively with an ulcer regimen and supportive measures. He improved steadily, and was discharged on December 3, 1956. He was instructed to continue his ulcer diet. The patient was again seen in the Out Patient Department on December 31, 1956. At this time, he complained of upper abdominal pain. He also claimed that he had obtained relief of pain by self induced vomiting. A repeat study of the upper gastrointestinal tract, performed on January 2, 1957, showed no evidence of abnormality of the esophagus. The stomach was noted to contain a considerable amount of residual food and gastric secretions. The prepyloric region appeared to be contracted (Fig. 2) and deformed with the appearance simulating an annular carcinoma of the antrum. The lesser curvature side of the stomach appeared ragged and suggested the presence of multiple ulcerations.

The patient was re-admitted so that he could

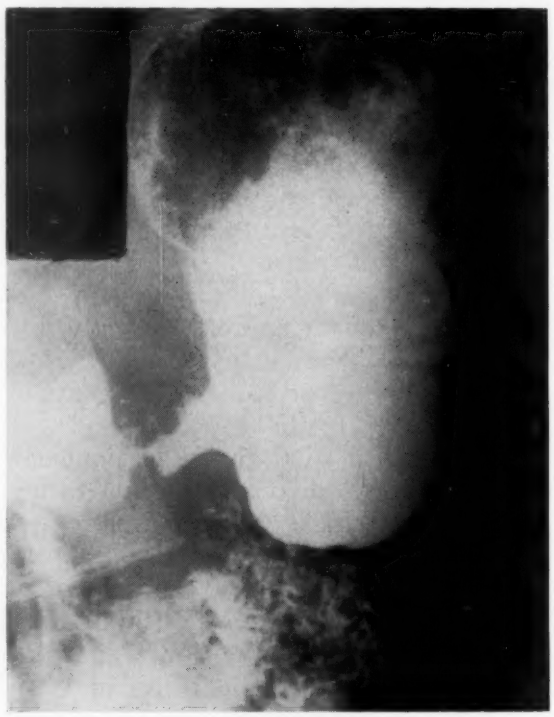

Fig. 2. Roentgenogram of the stomach (January 2, 1957). Attention is drawn to the narrowing of the antrum, ulcerations on the lesser curvature, and retained secretions and food particles in the stomach. The picture resembles an annular carcinoma of the antrum.

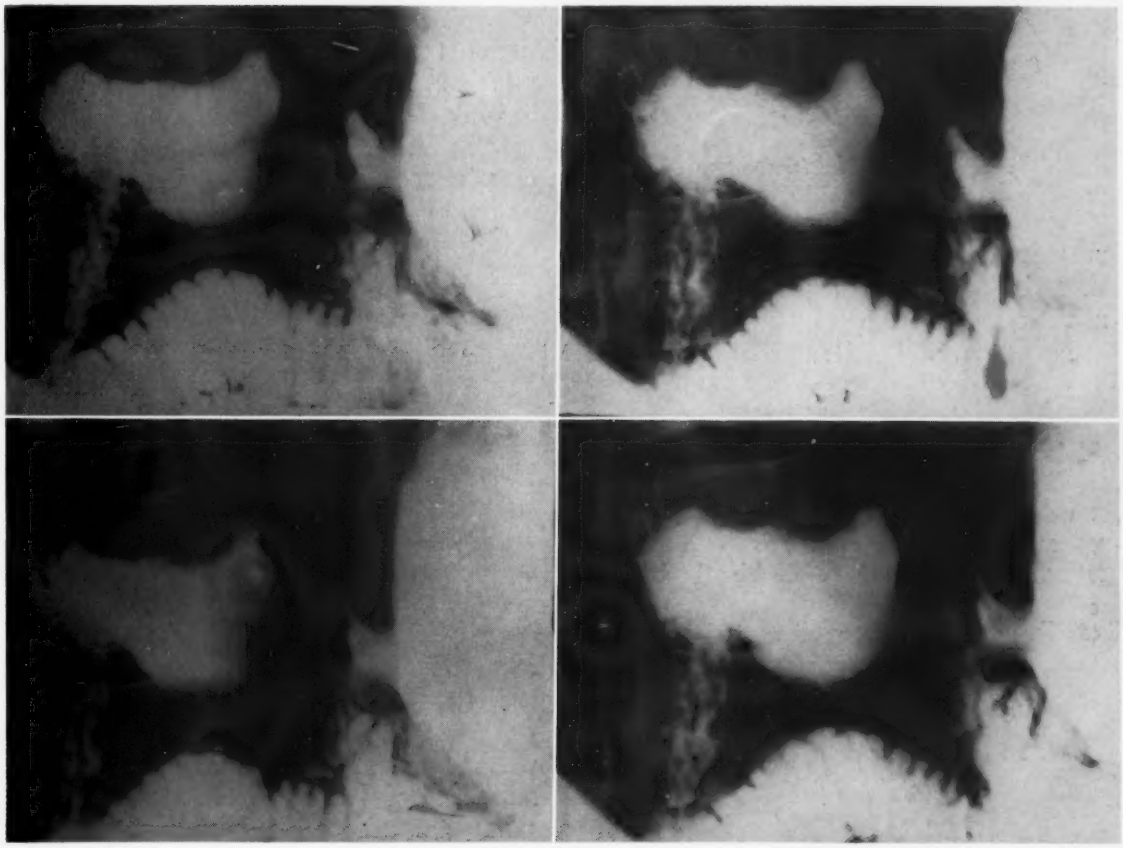

Fig. 3. Study of the antrum and the pylorus (February 27, 1957). The outlet of the stomach is contracted and there is persistent deformity of the superior border of the duodenal bulb.

be treated under supervision. On frequent feedings, the patient stopped vomiting, and his pain subsided over a period of a few days. On February 27, 1957, a repeat examination of the stomach was made. This study did not reveal the small ulcerations previously noted, but, instead, the lesser curvature in the region of contraction showed smoothly outlined pits in the scar tissue of the stomach outlet. The duodenal bulb showed some eccentricity due to retraction by antral scarring (Fig. 3). The patient continued to improve and became almost asymptomatic, even on a regular diet. Subsequent study on March 30, 1957 (Fig. 4) showed moderate dilatation of the stomach, which contained residual foods and secretions due to pyloric obstruction with marked deformity of the antropyloric junction. A repeat study on August 3, 1957, at which time the patient claimed to be free of symptoms, demonstrated marked contraction of the pylorus (Fig. 5) with small ulcerations along both sides of the pylorus. However, close questioning of the patient disclosed that he was minimizing symptoms to avoid being hospitalized and subjected to surgery, which had been recommended in the event that medical management failed.

DISCUSSION

A remarkable feature of this case is that although a considerable quantity of a corrosive substance was ingested, no ill effect could be demonstrated in the esophagus, and there were no symptoms referable to this portion of the upper gastrointestinal tract. It has been stated that acids seldom affect the esophagus in contradistinction to alkali which invariably produces burns of this organ. The following reasons have been advanced in explaining this difference: (a) Alkali is partially neutralized by the acid of the stomach; (b) ingested alkali is often stronger in concentration than the acids, and hence, it is held up by the cardio-

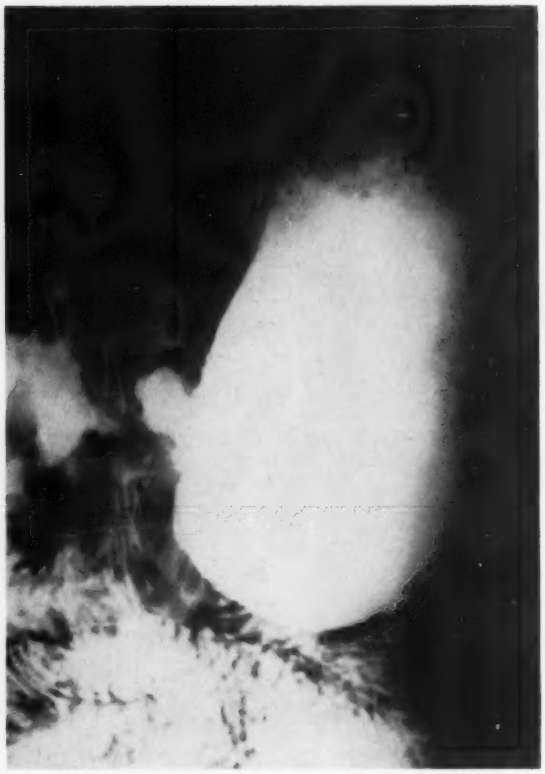

Fig. 4. Roentgenogram of the stomach (March 30, 1957). Note dilatation of the stomach, retained secretions, and food particles secondary to pyloric stenosis.

esophageal sphincter and rejected before it can reach the stomach. Nevertheless, about 10 to 20 per cent of cases with esophageal stricture show a pyloric lesion as well.[4] It is also speculated that there may be a selective action upon the cardioesophageal and pyloric sphincters by the alkali and acid, respectively; (c) normally, the stomach contains secretions and food particles which automatically dilute the corrosive agents; (d) the immediate effect of the corrosive substance upon the stomach causes such complications as shock, severe vomiting and even perforation. Many victims die before the cause of death is established or studied in details. Hence, fewer cases are reported.

In contradistinction to lye, which is the most common corrosive agent incriminated in producing esophageal stricture, the corrosive substances responsible for pyloric stenosis are many and varied. The following substances comprise a partial list: sulphuric acid,[4,5,8,11] hydrochloric acid,[1,7,9,14,16] formaldehyde,[18] tincture of iodine,[19] lysol,[14] ferrous sulfate,[12] acetic acid,[10] "clorox,"[15] chlorine (Eau de Javel),[17] household ammonia,[10] "Sani Flush,"[2] oxalic acid,[13] nitric acid,[10] trichloroacetic acid, carbolic acid, zinc chloride, copper sulfate, and potassium hydroxide.[4]

Physiopathology. In most reported cases of corrosive gastritis, the site of the lesion with few exceptions[10] seems to have been in the outlet of the stomach. The reasons for this site of predilection are: (a) the antrum and the pylorus constitute the most dependent portion of the stomach; and (b) the corrosive agent, which in most instances is a liquid, usually follows the "Magenstrasse" along the lesser curvature side of the stomach into the pyloric canal. Furthermore, at this region, the caustic material initiates a preantral spasm[16] which would tend to hold back the contents of the antrum. This prolongs the action of the irritant upon this region. This phenomenon has been observed in dogs by introducing a mixture of barium and a caustic material via a tube.[15]

The initial effect of the caustic substance upon the gastric mucosa is that of swelling of the mucosal surface,[13] manifested by enlargement of the mucosal folds roentgenologically. Then, depending upon the nature and the strength of the caustic agent, inflammatory reaction sets in, followed by necrosis of the affected mucosal or submucosal layers. Thrombosis of adjacent vessels has been described. Subsequent action of the gastric acid upon the denuded gastric surface gradually leads to a chronic inflammatory process, ending in severe scarring or stenosis. This latter complication often develops even after institution of medical management and finally necessitates surgical intervention.

SUMMARY

A case of pyloric stenosis secondary to corrosive gastritis is presented. Early and

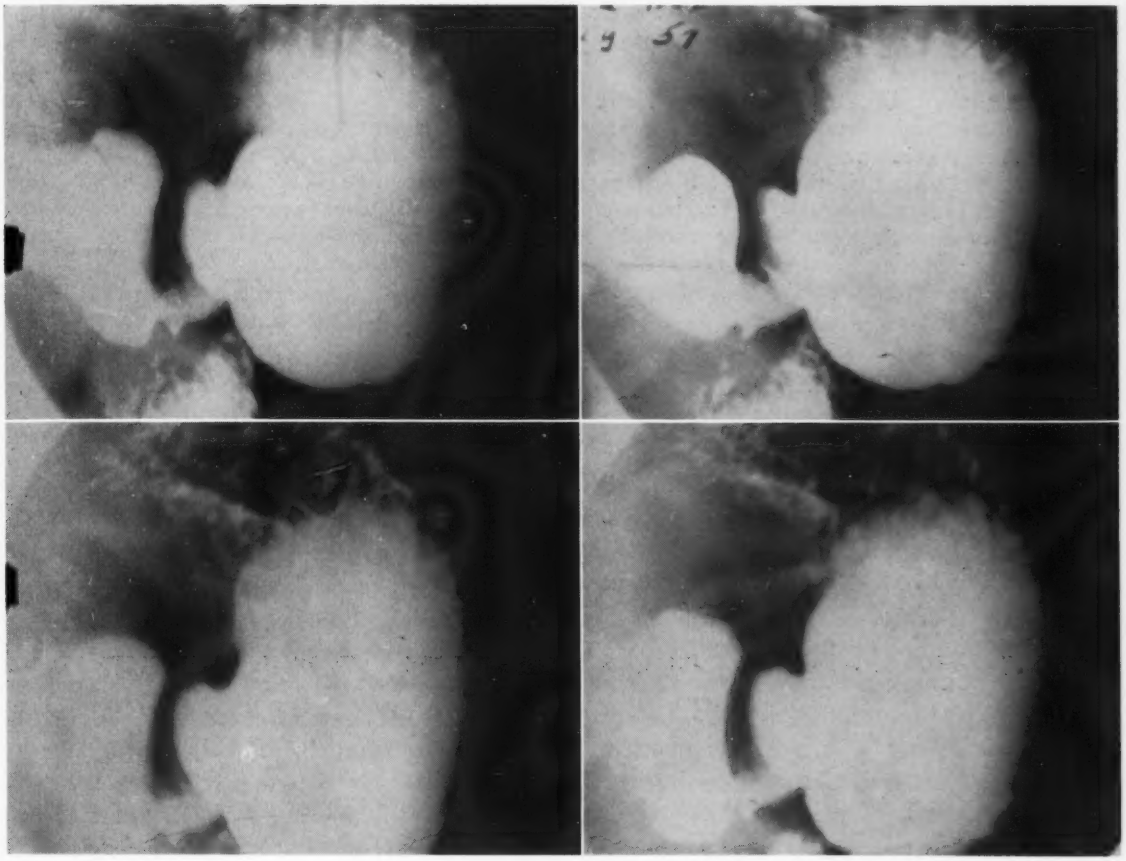

Fig. 5. Final study (August, 3, 1957). There is persistent pyloric deformity with ulcerations on both sides of the contracted outlet of the stomach and eccentricity of the duodenal bulb.

late roentgenologic findings of the case are illustrated. A brief discussion is included.

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THE VALUE OF DELAYED GASTRIC EMPTYING ROENTGEN STUDY OF THE ABDOMEN IN THE DETECTION OF ULCER, CARCINOMA AND OTHER ORGANIC DISEASE OF THE UPPER ALIMENTARY TRACT*

By JAY W. MacMORAN, M.D., ROBERT B. FUNCH, M.D., *and* BARTON R. YOUNG, M.D.
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A ROENTGENOGRAM of the abdomen exposed one hour following a barium meal administration has been used routinely in the Department of Radiology at the Germantown Hospital as a survey method of study for the small bowel and for the extent of gastric emptying. It has been a valuable diagnostic adjunct in the demonstration of organic disease of the stomach and duodenum, either inconclusively visualized or not detected by immediate examination. The one hour roentgenogram has been of appreciable help in evaluating the mucosal pattern of the stomach because a small amount of barium sulfate adheres to the rugal folds and thus distortion and ulceration of the mucosa are revealed. Occasionally, an "apparent" crater is visualized on this roentgenogram that was not seen either during fluoroscopy or on routine and spot roentgenograms exposed at the initial visit. At first, we were reluctant to accept this evidence as an indication of an ulcer, but in a number of patients it was so striking that additional fluoroscopy was done with confirmatory findings. We now feel that careful examination of the delayed one hour roentgenogram with regard to the gastric silhouette is a valuable adjunct for a "second look" at the stomach.

Two plausible explanations for the occasional good demonstration of a niche or crater on the one hour roentgenogram and poor or absent findings at fluoroscopy and on initial roentgenograms occurred to us. One of these concerns the volume of the opaque medium used in the examination. Unless the amount of barium sulfate is kept

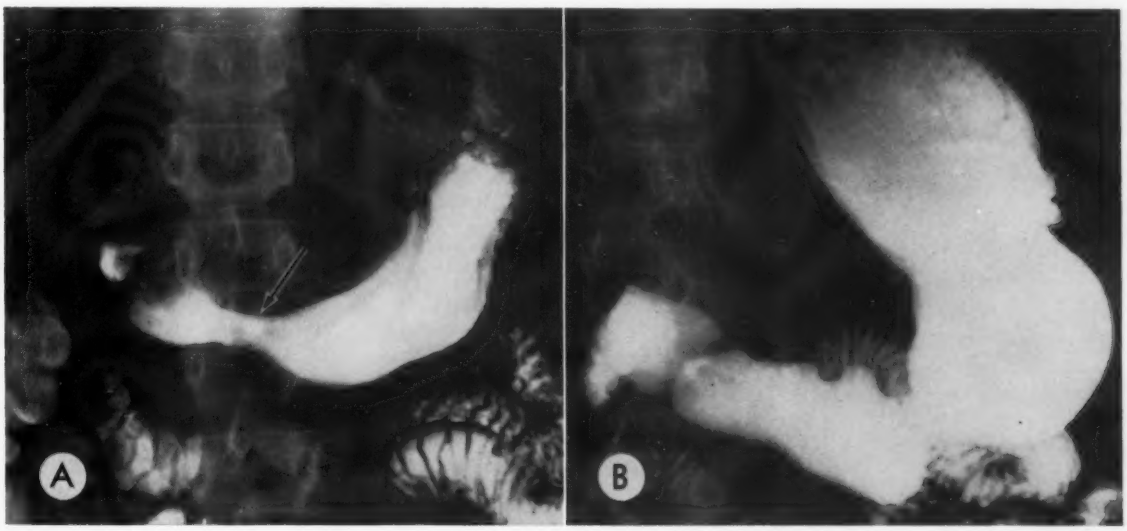

FIG. 1. Ulcer crater clearly demonstrated on one hour delayed roentgenogram (*A*) (arrow), but not seen either by immediate fluoroscopy or on routine roentgenogram (*B*). The superiority of the delayed roentgenogram is probably due to the decreased volume of barium and the compression effect of the spine.

* Presented at the Fifty-ninth Annual Meeting of the American Roentgen Ray Society, Washington, D. C., September 30–October 3, 1958.

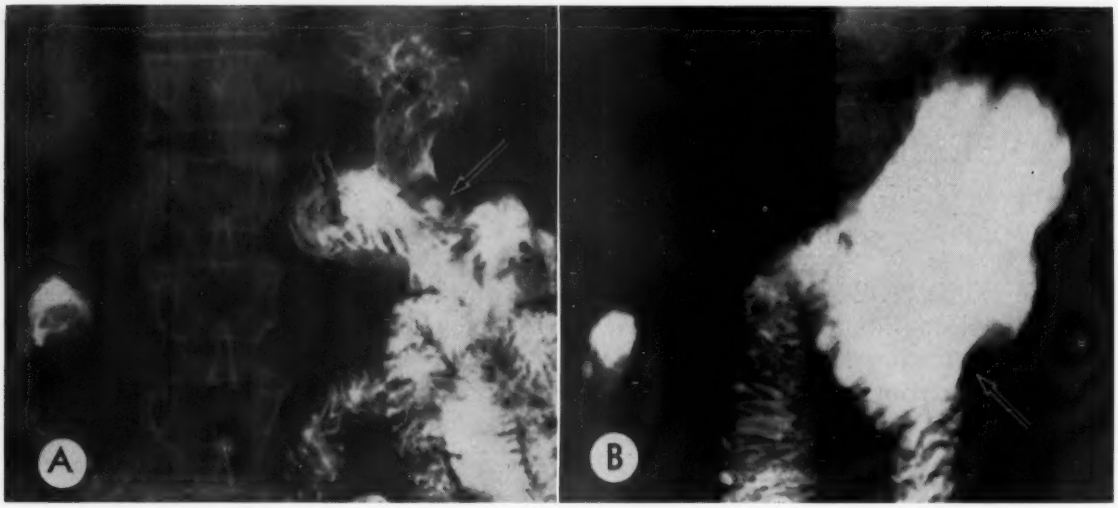

FIG. 2. Postgastrectomy ulcer crater visualized on delayed roentgenogram following probable displacement of mucous plug or necrotic debris (*A*) (arrow). Ulcer devoid of barium on original fluoroscopic and roentgenographic film study (*B*) (arrow). This ulcer was confirmed by subsequent fluoroscopy and spot roentgenograms. Note residual deformity of duodenal stump.

small throughout the initial stomach examination, some craters are not seen because they are covered by excessive opaque material. The one hour residue coats the folds and reveals the crater (Fig. 1). The second possibility is that barium sulfate either displaces a mucous plug, necrotic debris or even a blood clot, or perhaps it finds its way to the bottom of the crater after this material is dislodged (Fig. 2). Certain positions of the patient are advantageous for the demonstration of a gastric ulcer, but since the one hour roentgenogram is made with the patient prone,

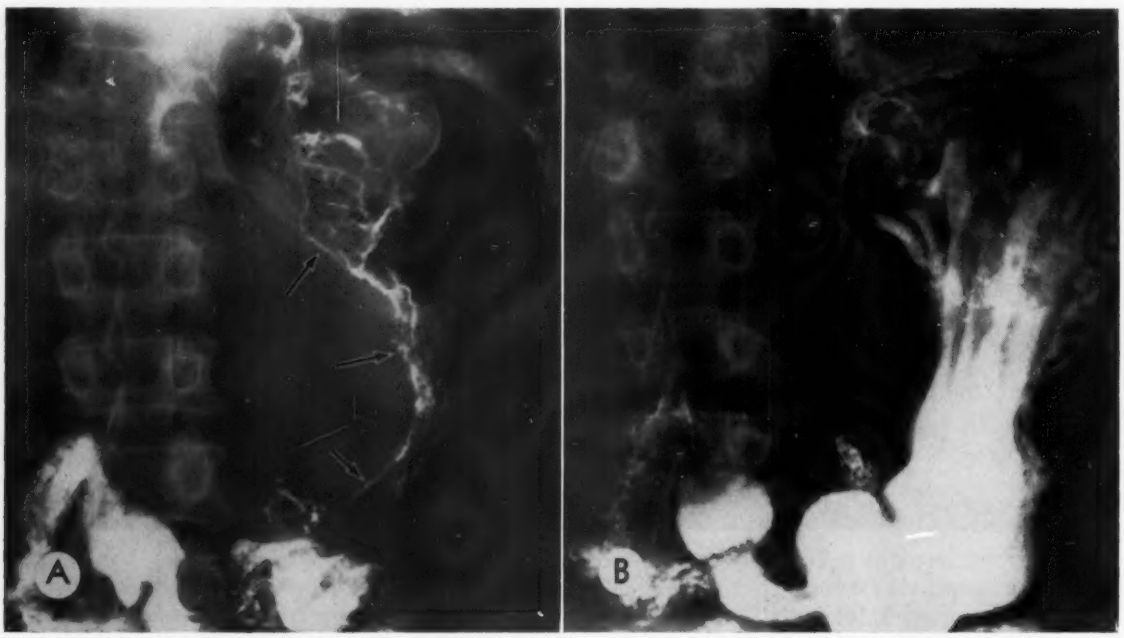

FIG. 3. Carcinoma of stomach extending from distal esophagus to antrum better depicted in its entirety on delayed roentgenogram (*A*) than on immediate roentgenogram (*B*).

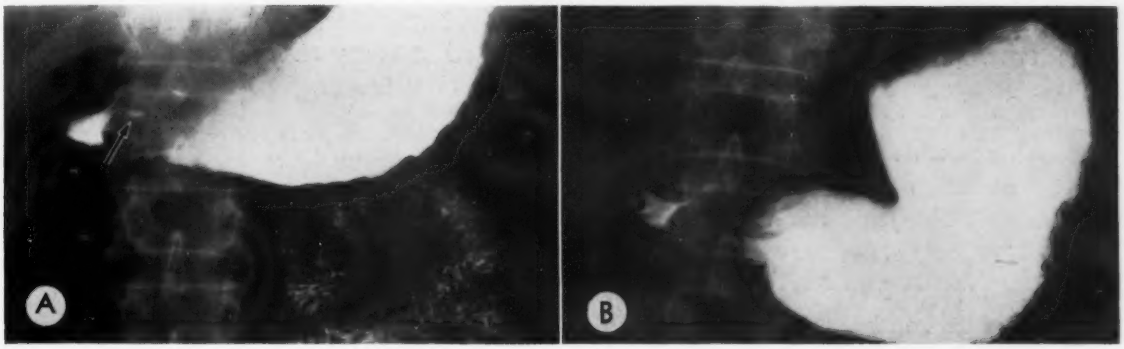

Fig. 4. Pyloric ulcer demonstrated on one hour delayed roentgenogram (*A*) not seen on immediate roentgenogram (*B*). Excessive retention of barium in the stomach is secondary to pylorospasm.

there is no reason to attribute the occasional good demonstration of a crater to this position alone.

In the same manner, space-taking lesions of the stomach are well outlined and a better estimate of the true extent of a carcinoma may sometimes be obtained (Fig. 3). Ulceration of a tumor is occasionally found on delayed roentgenograms when not seen soon after barium ingestion. Once again, we feel that this supports the hypothesis that a crater filled with mucous or necrotic debris may be seen when the barium replaces or mixes with the material in the ulcer.

Other disease, such as antral gastritis, can be well evaluated on the delayed roentgenogram, when the mucosa is well visualized. In one instance, a small gastric diverticulum was first seen on the emptying study because barium remained in it. The diverticulum was overlooked at fluoroscopy and was partially obscured on filled roentgenograms because of the opaque material in the cardia. This is one example when a viscus filled with barium may easily obscure disease and the true condition is brought to our attention by a small amount of contrast medium.

Recently, we have reviewed 100 representative cases and have found that in 83 per cent, the one hour delayed roentgenogram of the abdomen revealed the mucosal relief pattern, and therefore was valuable in evaluating the stomach and duodenum, and also the degree of gastric emptying. In 35 per cent additional help was obtained in locating an ulcer and estimating the true extent of carcinoma. In 3 of these cases, the diagnosis of an ulcer was made first from the delayed roentgenogram and then confirmed in 2 of these by additional subsequent fluoroscopy and spot roentgenograms. In the third case, the ulcer was clearly demonstrated in the pylorus by the one hour roentgenogram (Fig. 4).

Some other considerations of the delayed gastric emptying roentgenogram, as we have been using it, must be kept in mind. The amount of barium remaining within the stomach cannot be controlled, so that varying degrees of filling are seen. On occasion, all of the barium has already left the stomach in one hour. In addition, since this is a survey film, re-examination is indicated if an ulcer is suggested. This is not considered a limitation, since the diagnosis might be otherwise missed.

CONCLUSIONS

The delayed roentgenogram of the abdomen, exposed one hour after oral ingestion of barium sulfate, has proved of value in the diagnosis of gastric and duodenal ulcers, as a survey of small intestine physiology and morphology and as a determinant of the degree of gastric emptying. Ulcer craters either covered with excessive barium or filled with mucous or necrotic debris can occasionally be visualized. This roentgen study revealed the mucosal relief pattern of the stomach to good advantage

in 83 per cent of the cases reviewed, and in 3 cases the diagnosis of ulcer was first made on the delayed roentgenogram. It was of additional value in the visualization of hypertrophic rugae, small diverticula and in the estimation of the size and extent of gastric tumors. For the above reasons, a one hour roentgenogram of the abdomen is advocated in every examination of the upper alimentary tract.

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LYMPHANGIOMA OF THE DUODENUM*

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ONLY 10 cases of lymphangioma of the gastrointestinal tract have been described in the English literature.[1] The present report concerns another such case, this one occurring in the duodenum. To our knowledge, there has been no previous report of lymphangioma in the duodenum.

REPORT OF A CASE

L.M., a sixty-five year old white male, was admitted December 18, 1957, with a complaint of crampy right upper quadrant abdominal pain of nine months' duration, usually occurring after meals and nocturnally, aggravated by spicy foods, and relieved by eating and drinking milk. He denied nausea, vomiting, melena, jaundice, change in bowel habits or weight loss. He had had no previous surgery. Physical examination revealed an obese well developed white male with no abnormal findings. Urinalysis and blood cell counts were within normal limits.

Upper gastrointestinal roentgen examinations on November 21, 1957 and November 29, 1957 revealed a small hiatal hernia and a deformed duodenal cap. In the fourth portion of the duodenum, a circumscribed oval filling defect with intact overlying mucosa was demonstrated on both examinations. This filling defect was inaccessible to palpation. It was believed to be due to an extramucosal intramural lesion such as a leiomyoma (Fig. 1 and 2).

Surgery was performed on December 26, 1957. The deformity of the duodenal cap apparently was the result of adhesions from a chronically infected gallbladder containing nonopaque stones. In the superior wall of the fourth portion of the duodenum, near the ligament of Treitz, a soft, boggy, slightly irregular submucosal mass was found, measuring approximately 3 cm. in its greatest dimension. This appeared grossly benign and frozen section microscopically revealed a lymphangioma.

The pathologist reported the tumor to be 2 by 1 cm. in size, lying beneath the duodenal bowel mucosa and being of a milky appearance. On cutting through the tumor, milk-like fluid exuded from the tissue. Microscopically, a diagnosis of lymphangioma of the duodenum was made (Fig. 3).

FIG. 1. Right anterior oblique roentgenogram demonstrating lymphangioma of the fourth portion of the duodenum.

DISCUSSION

Lymphangioma is one of the least frequent of the benign tumors of the small intestine. Raiford[5] in 1932 reported an incidence of 37 cases of benign tumors of the small bowel in 11,500 postmortem examinations, and 13 cases from Johns Hopkins Hospital which included 45,000 surgical specimens. One lymphangioma was found in the jejunum at autopsy in a fifty-two year old Negro male. This was asymptomatic. Puppel and Morris[4] reported a case of lymphangioma of the jejunum in a fifty-five year old white female who presented complaints of anemia, weakness and me-

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FIG. 2. Spot roentgenogram of the lesion shown in Figure 1.

lena. The tumor was fungating, measured 6 cm. in diameter and protruded 1.5 cm. above the mucosa into the lumen of the bowel. Wild[7] described a lymphangioma of the jejunum found incidentally at surgery. Ehrlich and Hunter[2] found no lymphangiomas in a survey of 813 persons of military age who had tumors of the gastrointestinal tract during World War II. Weber and Kirklin[6] reported in 1942 from The Mayo Clinic a series of 108 malignant and 41 benign lesions of the small intestine. No lymphangiomas were found among them. Olson, Dockerty and Gray[3] more recently reported 77 benign small intestinal tumors. One lymphangioma was noted in the jejunum in a fifty-seven year old male undergoing surgery for duodenal ulcer. It was submucosal and measured 2 by 4 cm. Microscopically, the lesion resembled a cavernous hemangioma except that lymph instead of blood was filling the dilated spaces. Arnett and Friedman[1] found in 1956 that only 9 cases of lymphangioma of the gastrointestinal tract have been described in the English literature. Six arose from the jejunum or ileum and 3 from the rectum. They reported a case of lymphangioma of the ascending colon, which was the tenth reported instance of this tumor in the gastrointestinal tract.

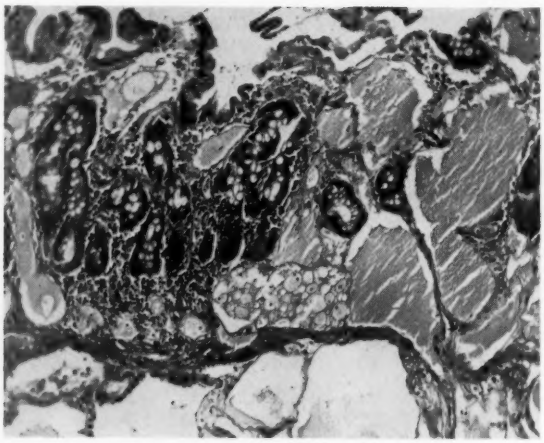

FIG. 3. Photomicrograph of lymphangioma of the duodenum (×100) showing dilated spaces containing lymph in the submucosa.

Lymphangiomas are thought to arise from the lymphatic plexus in the submucosa into which the lacteals of the villi empty. Two theories of etiology have been offered. Many believe the tumor develops from misplaced embryonic tissue, but evidence to support this is lacking. A more plausible cause seems to be stasis and back pressure brought about by blockage from the mesenteric glands.

Small bowel tumors may or may not be symptomatic. If symptoms are present, they can be of three types depending upon the type of tumor and its location: (1) obstruction; (2) bleeding; and (3) symptoms arising from local irritability. Intussusception may be found. Hematemesis is more likely to occur in lesions of the duodenum, particularly in leiomyomas. Symptoms of local irritability include ulcer-like pain, vague indigestion or dyspepsia, nausea, belching and occasionally vomiting.

ROENTGEN ASPECTS

Lymphangioma produces no characteristic roentgen pattern. The findings are those of a submucosal intramural tumor, usually with overlying intact mucosa. Arnett and Friedman[1] described changes in contour of a lymphangioma of the ascending colon, brought about by varying degrees of pressure and distention of the colon with air.

SUMMARY

A case of benign lymphangioma of the duodenum is reported with a description of the roentgen appearance.

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FOCAL CONSTRICTING INFLAMMATORY LESIONS OF THE SMALL INTESTINE*

REPORT OF THREE CASES

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DURING the past several years we have observed 3 cases of a focal or segmental inflammation of the upper part of the small intestine (duodenum and jejunum) which have differed in their roentgen features from those usually associated with regional enteritis. The individual lesions have simulated to some extent the appearance of an annular, constricting neoplasm. Studies of the specimens removed at the time of operation, however, have revealed only an inflammatory process. In 2, the findings were considered consistent with the diagnosis of regional enteritis. In the third patient with a single lesion the diagnosis was that of an inflammatory process, the etiology being undetermined. Because of the close resemblance of the roentgen findings in the 3 cases, the fact that they differ from the changes usually associated with regional enteritis or other localized inflammatory disease when it involves the upper part of the small intestine, and their similarity to annular carcinoma of the small bowel, they are being reported.

REPORT OF CASES

Case 1. R.S. The patient was a forty-year old white female, first admitted to University Hospitals on September 4, 1951 because of several episodes of numbness and blanching of the left fourth finger followed by throbbing pain. The patient gave a history of alcoholism of twenty years' duration. The disturbance in the hand was considered to be the result of vascular spasm (Raynaud's phenomenon). There were no complaints referable to the gastrointestinal tract. The second admission occurred on December 4, 1951 because of progression of the symptoms in the right hand and the development of similar difficulty in the left hand. About one week prior to this last admission, the patient had experienced vague epigastric pain occurring several hours after eating. At times the pain had been associated with nausea and there had been several episodes of vomiting. There was no hematemesis and no change in bowel habits. There had been a weight loss of 25 to 30 pounds. The only previous surgery had been an appendectomy in 1937.

Physical examination revealed dry gangrene involving the distal phalanx of the right third finger. The liver was palpable 3 cm. below the right costal margin and there was some tenderness to palpation in the right epigastrium. Routine laboratory tests gave normal findings. The diagnosis was Raynaud's disease.

Gastrointestinal roentgen examination demonstrated an annular constricting filling defect in the upper part of the jejunum with a slight dilatation of the bowel above the lesion (Fig. 1). An intrinsic tumor of the jejunum was considered the most likely diagnosis.

The gangrenous finger was amputated on December 11, 1951 and the patient was discharged. The third admission occurred on February 18, 1952 at which time the gastrointestinal symptoms had decreased and she was essentially asymptomatic so far as the digestive tract was concerned. Roentgen examination of the gastrointestinal tract demonstrated findings essentially similar to those noted before. On February 8, 1952 the patient was operated upon and the jejunal lesion was removed. No other lesions were found elsewhere in the gastrointestinal tract. The postoperative course was uneventful and she was discharged on March 6, 1952. There has been no follow-up.

Pathology. A 13 cm. segment of jejunum had been removed and a constricted area was present in its center. The lesion was 1.5 cm. in length. Proximal to it, the musculature of the bowel was moderately hypertrophied and the vessels injected. Distal to the lesion the bowel was normal. Through the constricted portion there were mucosal thickening and injection of

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Fig. 1. Case 1. Annular constricting lesion in the jejunum (arrow). There is sharp demarcation of the annular defect from normal bowel above and below with loss of mucosal pattern in the constricted area. The change from normal to abnormal pattern is abrupt and there is a tendency for overhanging edges.

Fig. 2. Case 11. Three lesions are demonstrated, one in the distal part of the duodenum (upper arrow), one in the proximal jejunum (center arrow) and a third at a slightly lower level which is visualized chiefly because it is obstructing the bowel (lower arrow). The upper two lesions are of short length (1–2 cm.), sharply demarcated from normal bowel and with loss of mucosal pattern in the strictured areas. The duodenal lesion is not obstructive.

vessels. There was one tiny focus of ulceration (3 mm.) on the mucosal surface covered by an inflammatory crust which was undergoing organization. Microscopically, acute and chronic inflammatory cells were numerous with several pockets of neutrophils within the inflammatory crust. The muscle was not involved. The diagnosis was inflammatory lesion of undetermined etiology (Dr. Walter Jaeschke).

Comment. The lesion was a relatively acute one and the paucity of symptoms in the presence of a partially obstructive lesion as demonstrated roentgenologically is noteworthy. In view of the vascular phenomena in the fingers, the possibility of the lesion being caused by vascular disease cannot be excluded but the examining pathologist did not find any evidence to support this impression (see Discussion).

Case 11. J.K. The patient was a sixty-one year old white female admitted on December 9, 1956 with the chief complaint of abdominal pain. The difficulty had begun approximately eleven months earlier as a dull epigastric pain with, occasionally, a sharper pain radiating to the back and right costal margin. It was aggravated by eating. For several months there had been episodes of nausea and vomiting. There had been a weight loss of 60 pounds (from 192 to 132). In July, 1956 she had been operated upon with repair of an umbilical hernia and lysis of adhesions around the gallbladder. This gave no relief and the pain had become progressively worse.

Physical examination revealed essentially normal findings other than some tenderness in the periumbilical area and in the left lower quadrant. Routine laboratory examination of the blood and urine gave negative results and the stools were negative for occult blood.

A cholecystogram revealed multiple small calculi in a normally functioning gallbladder. An excretory urogram was normal. An upper gastrointestinal roentgen examination demonstrated two annular constricting lesions, one in the third portion of the duodenum and the other in the proximal jejunum (Fig. 2 and 3). The duodenum and jejunum were dilated, the latter below the second constricting lesion and

Fig. 3. Case II. Lateral view of stomach and upper part of small bowel showing two of the lesions, one in the duodenum (upper arrow) and one in the jejunum (lower arrow). The jejunum is dilated below this latter lesion, indicating the presence of a third lesion lower down.

indicating that there was a third and more obstructive lesion distally. The character of these lesions is depicted in the accompanying illustrations. Because of the multiplicity of the lesions, it was considered most likely that they were on an inflammatory basis.

An exploratory laparotomy was done and the three constricting lesions were identified plus two others which had not been recognized roentgenologically. The two most distal ones were resected and an end to end anastomosis performed. A posterior retroperistaltic gastroenterostomy also was performed as a shunt around the remaining lesions. The postoperative course was uneventful. The patient was last seen eleven months after the operation and had no complaints referable to the gastrointestinal tract. Roentgen examination was not done. Her weight had increased to 172 pounds.

Pathology. The lesions in the resected specimen of jejunum were fibrotic appearing, annular constrictions each approximately 1 cm. in length. The bowel between the lesions appeared normal. The lesions bounded the mucosa like a belt. There was no ulceration. Microscopic section of one of the band-like lesions revealed degeneration of mucosal epithelium, massive invasion of the subepithelial connective tissue with lymphocytes and plasma cells, and a fibrous thickening of the outer layers of the wall. There were hypertrophy and hyperplasia of a regional lymph node which was included with the specimen. The diagnosis was regional enteritis of undetermined type (Dr. Walter Jaeschke).

Comment. The appearance of the individual lesions as seen in the roentgenograms resembled rather closely that more commonly associated with annular carcinoma. The multiplicity of lesions was in favor of inflammatory process but multiple neoplasms of the small intestine are not unknown, particularly carcinoids.

Case III. C.N. The patient was a twenty-nine year old white male first admitted to the Madison Veterans Administration Hospital on September 3, 1957 with the diagnosis of anemia of microcytic type secondary to blood loss. The only complaint referable to the gastrointestinal tract was a mild pain in the right upper quadrant which appeared about two hours after meals. The hemoglobin varied from 9 to 10 gm. at the time of admission. The white blood cell count was normal but there was evidence of anisocytosis and poikilocytosis.

Except for slight tenderness in the left epigastrium and a palpable liver, the physical examination was essentially normal.

Gastrointestinal roentgen examination done on September 18, 1957 and repeated two days later demonstrated a questionable area of narrowing in the jejunum.

The patient was discharged and re-admitted on October 7, 1957. The hemoglobin again was 9 gm. Patient complained of easy fatigability with some dyspnea on exertion and ankle edema. The diagnosis again was that of iron deficiency anemia secondary to blood loss. The guaiac test of the stool showed a trace of occult blood.

A third gastrointestinal series was done on November 25, 1957 and this demonstrated an area of localized constriction approximately 2 cm. in length in the upper jejunum. The bowel was dilated for a short distance below this and a

second lesion was believed to be present to account for the dilatation (Fig. 4 and 5). The lesions were considered to represent inflammatory disease of undetermined etiology.

On December 10, 1957 the patient was operated upon. In the lower part of the jejunum a localized lesion was found causing thickening of the bowel wall. The serosa over the lesion had a pebbly appearance. Two other lesions with similar characteristics were found distally with normal bowel between them. Lower down, several other areas of disease which did not involve the entire circumference of the bowel were observed. Several slightly enlarged lymph nodes were found in the mesentery. One of the small stenosing lesions was resected and an end to end anastomosis performed.

Pathology. The specimen consisted of a 3 cm. segment of small intestine. The serosal surface was granular and the wall was thickened. The mucosa was flattened and smooth over a 1.5 cm. distance in the mid-portion of the specimen. Microscopically there was some ulceration of the mucosa with edema of the submucosa. The surface of the ulcerated area was covered by a layer of necrotic material heavily infiltrated by neutrophils. There was fibrous tissue proliferation beneath this and extensive infiltration by lymphocytes, plasma cells and a few eosinophils. The serosa was edematous and infiltrated by lymphocytes, plasma cells and a few neutrophils. A lymph node which had been removed was essentially normal. The diagnosis was regional enteritis (Dr. D. J. Stevenson). The postoperative course was uneventful.

Fig. 4. Case III. Small bowel study demonstrating two annular lesions involving the jejunum (arrows). Note resemblance to findings in Case I and II.

Fig. 5. Case III. Two hour small bowel roentgenogram. One of the lesions in the lower part of the jejunum is depicted (arrow). There are areas of slight irregularity in a coil of ileum in the right lower quadrant probably representing sites of involvement, nonannular in nature. These were not recognized at the time of examination but plaque-like lesions were found at laparotomy in addition to the annular constrictions.

The patient was last seen on May 14, 1958, approximately six months after the operation, and at that time he felt well. The hemoglobin on January 9, 1958 was 11 gm., on March 12, 1958 it was 10 gm. and on May 14, 1958 it was 14.2 gm. The patient had maintained his weight but complained of occasional mild epigastric pain.

Comment. The appearance of the lesions roentgenologically and pathologically resembled those in Case II. The lack of significant obstructive symptoms is noteworthy and there likewise was no history of diarrhea. The presenting complaints were mainly referable to chronic blood loss anemia. In spite of the fact that only one of the lesions was removed, the patient had no significant complaints referable to the gas-

trointestinal tract at the time of last observation.

DISCUSSION

Following Crohn and co-workers'[6] description of the entity which they termed regional ileitis, it soon became apparent that the disease might occasionally involve the jejunum.[1] Earlier reports suggested that jejunal disease was generally accompanied by ileal disease, either as a direct upward extension of the process or occurring in the form of "skip" areas developing secondary to disease which initially originated in the ileum. It was suggested that, while terminal ileitis was characterized by a localized granulomatous mass with fistula formation and obstructive phenomena, the jejunal lesions were usually nonobstructive, without localized mass and without fistulae.[7]

Further experience[1,5,9] has expanded the original concepts of the disease and primary involvement of the jejunum, while much less common than ileitis, is by no means rare. It has also become apparent that jejunal disease generally resembles that found in the ileum both pathologically and roentgenologically.[12] Occasional cases of regional enteritis have been reported as occurring in the duodenum, and gastric and esophageal lesions have been observed resembling those found in the ileum.[3,4]

Marshak and Wolf,[10] in a study of 12 cases of regional jejunitis, found marked stenosis in every one. Three types of stenosis were observed: (1) a single area with dilatation of the bowel proximal to it; (2) two areas of narrowing with dilatation between them; and (3) multiple stenotic segments. In the illustrations accompanying their article, the areas of disease appear as smooth constrictions with tapering ends, a characteristic of inflammatory stenosis wherever it occurs in the gastrointestinal tract.

In an extensive study of regional enteritis dealing mainly with the pathologic aspects, Van Patter *et al.*[12] reported the length of the initial lesion in 315 specimens. In 22 the length varied from 2 to 5 cm., in 47 it was 6 to 10 cm., in 86, 11 to 20 cm., and in the remainder the lesions were more than 20 cm. in length. The majority of lesions, therefore, measured more than 6 cm. in length.

The characteristic roentgenologic features of a localized inflammatory lesion of the small intestine include the tendency for tapering of the lumen from dilated or normal caliber into an area of constriction, a concentric type of narrowing, and involvement of variable length but usually more than 2 or 3 cm. The mucosal folds may show different degrees of alteration but often are flattened to the point of complete obliteration or else may have a rough cobblestone appearance.

In the cases described above, the individual lesions did not show the tapering ends usually associated with an inflammatory process. The change from normal to constricted area was abrupt and there was actually a variable degree of overhanging of the edges. This led to a resemblance to napkin ring carcinoma. However, the multiplicity of the lesions in 2 of the cases and the similarity of one to another was a striking feature and the most significant finding to aid in the differential diagnosis. As visualized on the roentgenograms, the lesions varied in length from 2 to 2.5 cm. In the pathologic specimens the lengths of the lesions were reported as measuring from 1.5 to 2 cm.

Among the lesions that were considered in differential diagnosis, the most important were (1) carcinoma, (2) carcinoid and (3) primary ulcer of the jejunum. Carcinoma of the small intestine is an uncommon lesion and it is extremely rare to find it as a multiple process. Carcinoid tumors (argentaffinoma) are frequently multiple when they occur in the small intestine. The roentgenologic features of carcinoid are those of an irregular filling defect with a tendency for kinking of the bowel. The tumor invades the wall and infiltrates the mesen-

tery, leading to fibrosis and kinking of the loop with adherence of the peritoneal surfaces.

Primary ulcers of the jejunum, other than those occurring secondary to gastroenterostomy or gastric resection, are rare. Descriptions of this entity as given in the literature indicate that it may vary from a niche-like crater resembling ulcer of the stomach or duodenum to an obstructing process in which the roentgen signs are only those of obstruction.

Not infrequently lesions of the small intestine, regardless of their nature, cause obstruction and it may be impossible to visualize enough of the defect to determine very much about its nature. Even when the obstruction is partial, the defect caused by the lesion may be obscured by overlying loops and only the evidence of dilated bowel is noted. In these cases the roentgenologist may be limited to the diagnosis of an obstructive lesion of undetermined type.

In Cases II and III the disease was considered to be a localized form of regional enteritis. In Case I, with a single lesion, the nature of the process is uncertain. The possibility of vascular disease as a cause was considered in view of the clinical diagnosis of Raynaud's disease affecting the fingers. The lesion bears some resemblance to the cases described by Wolf and Marshak[13] as segmental infarction of the small intestine, but no proof of this assumption is obtained from a study of the pathologic specimen. The roentgen appearance of the lesion in this case did not differ significantly from the findings noted in the other two. Considering the group as a whole the lesions that could be recognized individually varied from 2 to 3 cm. in length. All were characterized by sharp margins both proximal and distal and with a tendency for overhanging edges. In some there was a slight to moderate central enlargement within the strictured area. Each showed the napkin ring features of a concentric stenosis. While the lumen tended to taper from the edge inward, there was an abrupt change in the mucosal folds which were completely obliterated within the stenotic area. The sharp demarcation and localized nature of the lesion was confirmed at the time of operation.

SUMMARY AND CONCLUSIONS

1. Three cases are reported showing one or more localized areas of concentric stenosis of the small intestine on an inflammatory basis. Pathologically, the lesions were identified as regional enteritis in 2 of the cases; in the other with a single lesion the possibility of vascular disease as a cause for the process cannot be excluded.

2. Roentgenologically, the individual lesions were characterized by shortness in length, an annular napkin ring appearance and variable degrees of obstruction. In one patient there was a lesion in the duodenum; otherwise, the areas of the disease were confined to the jejunum. Slight mucosal ulceration was present in the specimens in 2 of the cases but the punched out appearance of a primary jejunal ulcer was lacking.

3. In 2 of the cases the lesions appeared to represent a variant of regional enteritis in which the area of disease was more sharply limited than is seen in the usual case of this disease. In the third case the patient showed changes secondary to Raynaud's disease in the fingers, and the possibility of vascular disease as a cause for the intestinal process cannot be eliminated.

4. Differential diagnosis of this form of inflammatory disease involving the duodenum or jejunum is difficult only when a single lesion is identified roentgenologically. Then the resemblance to annular carcinoma of the small intestine is striking.

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THE SMALL INTESTINE IN WHIPPLE'S DISEASE*

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WHIPPLE's disease is an uncommon entity of unknown etiology, characterized by intestinal malabsorption and specific pathologic findings. Since the original description in 1907,[47] approximately 70 cases have been reported.[4,5,17,32,33,35,36,37] Most of these cases were diagnosed at necropsy; in several, the diagnosis was made during life by exploratory laparotomy and biopsy.[31] Recently, attention has been called to the specificity of clinical and laboratory findings which might permit an antemortem diagnosis.[33] Characteristic histologic features have been described in biopsy material from enlarged peripheral lymph nodes[35] and from the duodenal mucosa obtained via the transoral route[3] (Case II). Interest has been further heightened by several observations of a beneficial response to corticosteroid therapy.[25,27,34,36,39,41,45] Several authors have indicated clinical similarities between this disease and the collagen disorders.[5,32,33] Despite this attention, little has been written concerning the roentgen findings in the small intestine except for vague reference to "small bowel dysfunction" and to abnormal motility as judged by transit time.[32,36] The purpose of this paper is to describe 3 cases of Whipple's disease with special reference to the roentgen findings in the small intestine and to report a complication of cecal volvulus (Case I).

CLINICAL FINDINGS

A review of published reports[32,33,35,36] shows that the disease is characterized by a progressive downhill course, with death within a few years after the diagnosis is established. Males, frequently of middle age, are affected predominantly and only a few cases have been described in females. Polyarthritis was the initial symptom in 50 per cent of cases and is usually antecedent to, and disappears after, the onset of diarrhea; the joint symptoms are indistinguishable clinically from those of rheumatoid arthritis, and roentgenographic examination of the joints may show structural changes,[7,38] but this is not common. The joint symptoms are regarded as a manifestation of generalized polyserositis. The presenting symptom in half of the cases is diarrhea or abdominal pain. The diarrhea is characteristically intermittent and need not be associated with gross steatorrhea; in many of the cases it was described as watery. The abdominal pain may be crampy and is usually ill-defined. It may be associated with a subjective feeling of distention. Weakness and loss of weight are usually present. A chronic, nonproductive cough is a frequent symptom. Gross rectal bleeding and generalized purpura may be seen, but these are usually apparent in the later stages of the disease.

Emaciation is usually present and a peculiar gray-brown pigmentation of the skin, also described as having a muddy appearance, has been noted in half the cases. There frequently is generalized, discrete, peripheral lymphadenopathy. A systolic blood pressure of less than 100 mm. of Hg has been seen in approximately two-thirds of the cases. A doughy abdominal mass has been palpable in some cases. The anemia which is described is almost always hypochromic or normochromic microcytic; a macrocytic anemia has not been seen. Gastric achlorhydria is frequently present. A flat oral glucose tolerance curve is characteristic and, on chemical analysis, there is usually an abnormal increase in fecal fat.

PATHOLOGIC FINDINGS

Little has been added in recent years to Whipple's original pathologic description. Although the clinical findings may at times be confused with idiopathic sprue, the pa-

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thology of Whipple's disease is quite characteristic. The small intestinal wall is thickened, as are the mucosal folds. The serosal aspect often shows minute yellow flecks. The esophagus, stomach and colon are not involved, although involvement of the caput cecum may be seen (Case III). The small bowel mesentery is frequently thickened and edematous; the mesenteric and retroperitoneal lymph nodes are enlarged, yellowish in color and have a spongy appearance on cut section. The peripheral lymph nodes may also be involved. Fibrinous polyserositis may involve the pleura, pericardium and peritoneum. Cardiac valvular vegetations have been described.

Microscopically, one notes a diffuse infiltration of the mucosa of the small bowel by large mononuclear macrophages which possess abundant granular cytoplasm imparting a foamy appearance to the cell. The cytoplasm stains faintly basophilic with hematoxylin and eosin and gives a positive reaction to periodic acid Schiff reagent. These cells are present in the mesenteric and retroperitoneal lymph nodes and have been demonstrated in peripheral lymph nodes as well.[35,44] The lacteals in the small bowel are dilated and frequently contain these macrophages. Collections of neutral fat and fatty acids are present in the dilated lacteals and within granulomatous foci in the mesenteric lymph nodes. The mucosal villi are swollen due to the cellular infiltration, and the submucosa may be edematous. The tunica muscularis is not significantly altered.

LITERATURE

Whipple[47] originally described an abnormal accumulation of fat and fatty acids in the lamina propria of the small intestine and in the mesenteric lymph nodes. Although he noted the aggregates of abnormal Sudan-negative macrophages at these sites, he proposed the term "intestinal lipodystrophy" and thought that the disease was due to abnormal fat metabolism. Involvement of extra abdominal lymph nodes was first described in 1938.[26] Little attention was paid to the cytoplasm-rich macrophages and to the important observation that they were Sudan-negative until Black-Schaffer,[2] in 1949, showed that these cells reacted positively to the periodic acid Schiff (P.A.S.) test; he concluded that the abnormal foamy cytoplasm was rich in glycoprotein. Upton[44] confirmed these histochemical studies and emphasized widespread extra abdominal dissemination of foam cells. Whether the P.A.S. positive material is derived from mucin or a connective tissue mucopolysaccharide or is actually a lipoprotein, like kerasin, is not clear.[23] Whipple felt that he was dealing with an obscure disease of fat metabolism. Black-Schaffer,[2] Hendrix *et al.*[17] and Jones *et al.*[23] have advocated that the primary fault is a metabolic defect in the small intestinal mucosa. Hill[19] was the first to propose the idea of mechanical obstruction, but he thought that the disease was due to a chronic infectious lymphadenitis. Others[6,37] have emphasized that diffuse lymphatic obstruction represents an important part of the pathologic picture. It is possible that the P.A.S. positive material is elaborated by the intestinal mucosa and phagocytosed by the mononuclear cells,[6,23,44] or perhaps it originates within these cells.[4] The abnormal protein-polysaccharide complex may be related to certain enzymes necessary for fat absorption and transport.[2,4] Clemmesen[5] related the disease to an allergic reaction, and Peterson and Kampmeier[32] suggested that it belongs to the collagen group of diseases on the basis of clinical similarities. Plummer *et al.*[34] have noted a beneficial response to ACTH but not to cortisone and think an important steroid, not cortisone, which is elaborated in the adrenal cortex, is deficient. Certain clinical features have suggested that adrenal insufficiency is an integral part of the disease,[23] but this has not been supported by clinical and pathologic studies.[17] The possibility that there is a genetic factor in the etiology has also been raised.[35]

REPORT OF CASES

Case 1 (No. 877983). This thirty-five year old white male consulted his physician in 1956 because of progressive weakness, fatigue and weight loss. He gave a history of migratory arthralgias, mainly in the joints of the hands and wrists, and swelling of the proximal interphalangeal joints, in 1955 and in early 1956, which did not recur subsequently. Examination of the abdomen suggested the presence of a mass and the patient was therefore subjected to exploratory laparotomy in December, 1956. A biopsy specimen of omental tissue was diagnosed as Whipple's disease. The patient was an only child, and the family history was unremarkable.

He was first admitted to the University Hospital in August, 1957. He complained chiefly of intermittent, crampy, generalized abdominal pain and bloating, and, more recently, of watery diarrhea. He denied foul or fatty stools and rectal bleeding. Meticorten therapy had been started in March, 1957. On physical examination the heart and lungs were found to be normal, as were the vital signs. There was a questionable mass palpable to the right of the umbilicus. Inguinal lymph nodes were palpable bilaterally. Blood hemoglobin was 9.1 gm. per cent and the white blood cell count, 13,000, with a normal differential. Urinalysis was negative. The stools gave a 4 plus guaiac reaction on three occasions. The total serum protein was 4.8 gm. per cent with A/G ratio 3.4/1.4. Serum cholesterol was 100 mg. per cent. The fasting blood sugar was 78 mg. per cent. An oral glucose tolerance test showed the blood sugar to be 100, 119, 111 and 85 mg. per cent at one, two, three and four hours, respectively. Intestinal absorption studies by chemical analysis, over a five-day period, gave a coefficient of fat absorption of 30 per cent and a 70 per cent coefficient for nitrogen. Biopsy of an inguinal lymph node was compatible with Whipple's disease.

Roentgenograms of the chest showed an infiltration in the right upper lobe and a small right pleural effusion; this cleared subsequently. Examination of the upper gastrointestinal tract showed the esophagus, stomach and duodenal bulb to be normal. There was minimal dilatation of the duodenum and proximal jejunum. The mucosal folds in the jejunum were markedly thickened (Fig. 1). The barium column

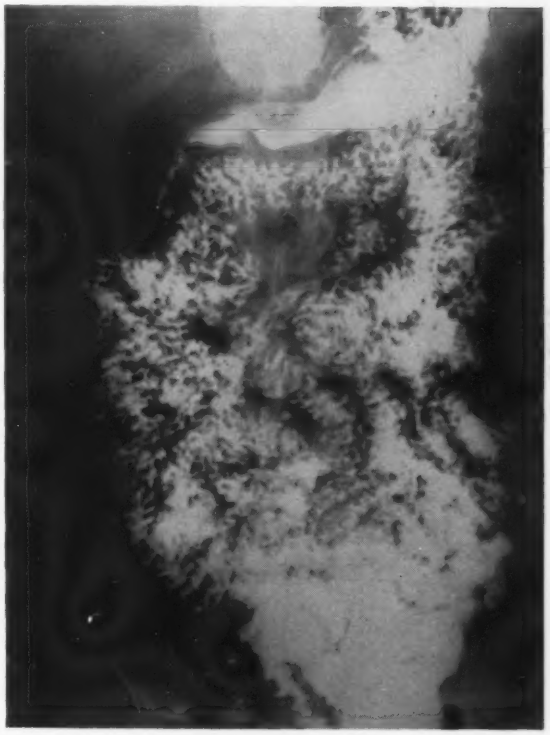

Fig. 1. Case 1. Marked diffuse thickening of the mucosal folds. The lumen of the small bowel is not significantly widened.

began to show segmentation in the jejunum after two and a half hours (Fig. 2*A*), but segmentation in the ileum was marked at five and a half hours, with slight increase in caliber (Fig. 2*B*). The barium had a coarse granular appearance, within the opacified segments; there was coarse scattering of the barium as the loops emptied. The head of the column reached the cecum in six hours.

The patient developed gross rectal bleeding and diarrhea in December, 1957 and complained of intermittent crampy abdominal pain. Barium enema study showed the cecum to be mobile; the colon was not dilated (Fig. 3*A*). Small bowel examination confirmed the abnormalities previously described, with more marked thickening of the jejunal mucosal folds at this time. He was readmitted in January, 1958 with the same complaints, and his condition deteriorated despite steroid therapy. While in the hospital, approximately six weeks after admission, he noted dull, crampy abdominal pain which was associated with progressive abdominal distention; a dilated loop of bowel

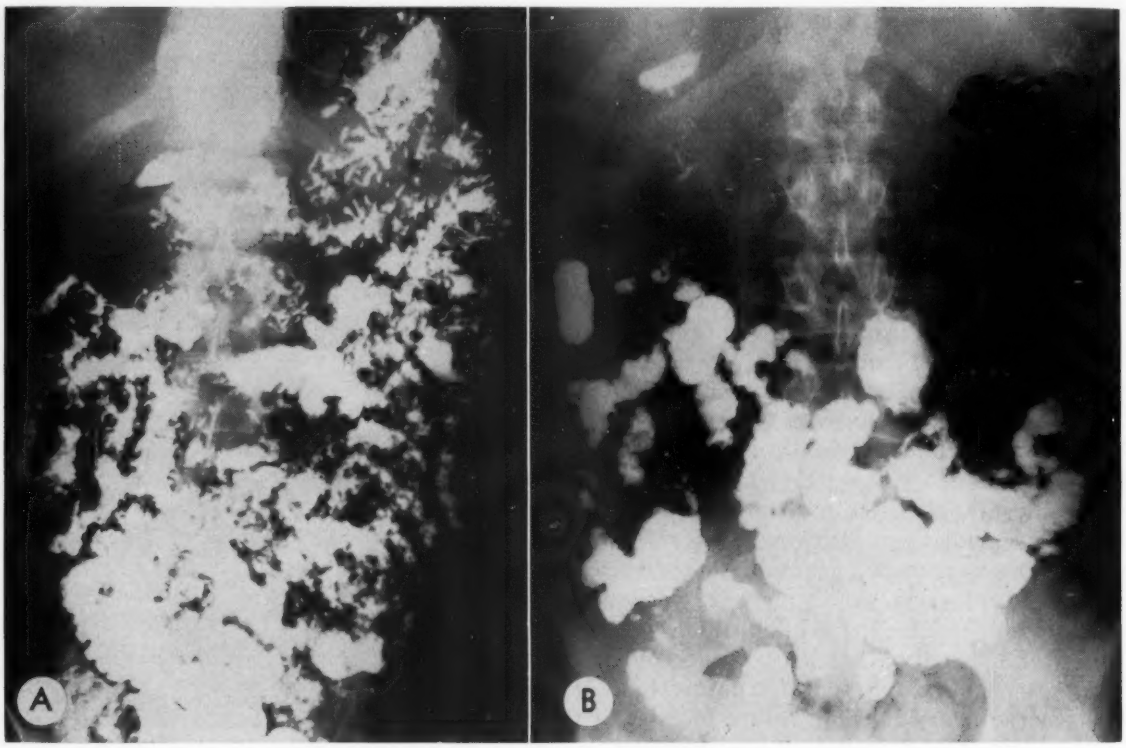

Fig. 2. Case 1. (*A*) Segmentation two and one-half hours after ingestion of barium. (*B*) Segmentation in the ileum at five and one-half hours.

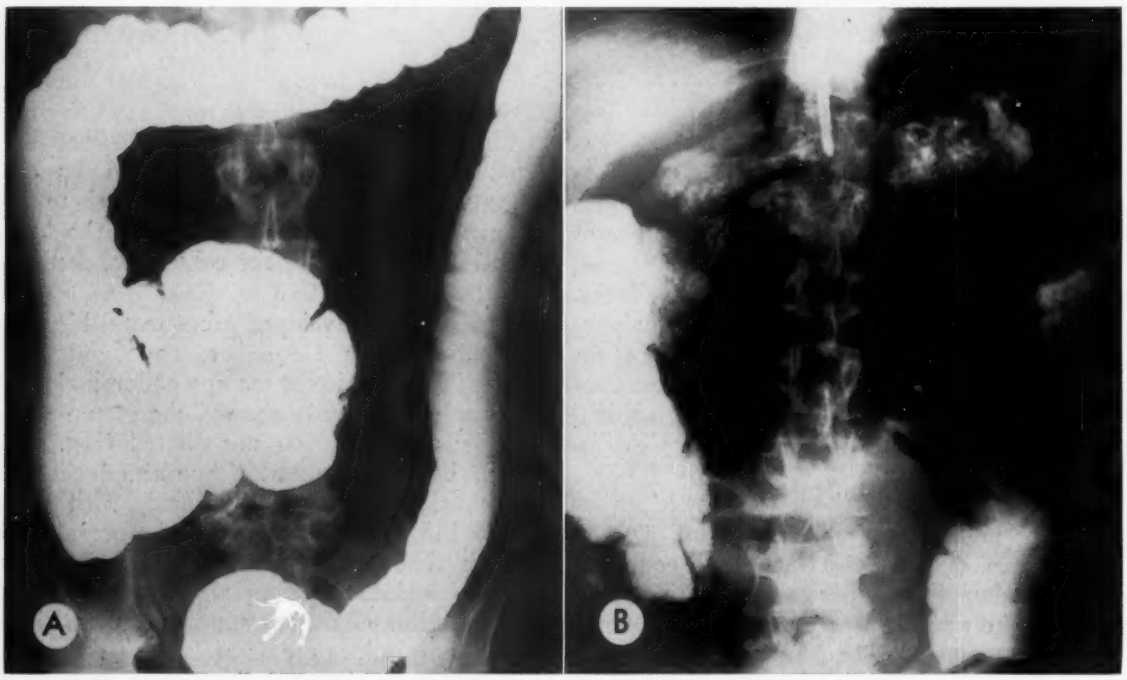

Fig. 3. Case 1. (*A*) The cecum is directed medially and was mobile on barium enema examination, two months prior to the development of cecal volvulus. (*B*) Volvulus of the right side of the colon. A small amount of miokon was introduced into the upper gastrointestinal tract via the tube in the stomach. The cecum is in the left upper quadrant and is extremely dilated; gas is present in the wall of the cecum.

was palpable to the left of the umbilicus. The stools were watery and chocolate in color. On the fifth day following the onset of pain, a plain roentgenogram of the abdomen showed a dilated loop of bowel extending transversely in the left upper quadrant. A barium enema examination demonstrated volvulus of the cecum with gas in the cecal wall (Fig. 3*B*).

At operation, the cecum and proximal ascending colon were markedly dilated, twisted 360° and necrotic. Gas was palpable within the wall of the necrotic cecum, which was adherent to the splenic flexure. The blood supply to the terminal ileum was also compromised. The entire small intestine was yellowish in color; its walls were diffusely thickened, and its mesentery was studded with small yellow nodules. Sections of ileum, proximal to the devitalized portion, showed the mucosa to be infiltrated by large, pale macrophages with gray, granular cytoplasm and large centrally placed basophilic nuclei. There was marked submucosal congestion and edema. The lymphatic channels were dilated, and many contained aggregates of "foam" cells (Fig. 4, *A* and *B* and Fig. 5).

On the fourth postoperative day the patient developed petechiae and areas of ecchymosis. There was marked thrombocytopenia and atypical mononuclear cells were present in the peripheral smear. Sternal marrow biopsy showed extensive replacement by these mononuclear forms. He developed continuous drainage from the abdominal wounds; his condition deteriorated, and he quietly expired.

Postmortem Examination. The body was extremely emaciated and there were generalized petechiae and ecchymosis but no abnormal pigmentation. A generalized fibrinopurulent peritonitis was present with serosal petechiae and ecchymosis. There was a moderate bilateral pleural effusion and petechiae on the epicardial and pericardial surfaces. Cardiac valvular lesions were not present. The mesenteric lymph nodes were enlarged, yellowish and granular on cut section. The mucosal folds of the small bowel were diffusely thickened, but the mucosae of the stomach and colon were unremarkable. The liver was slightly enlarged but was of normal color. The spleen was of normal color and size, but was slightly diffluent. The bone marrow was not remarkable. Microscopically, the heart showed some fibrous thickening of the epicardium and collections of foam cells but no valvular lesions. Similar cells were present in the thymus, spleen, liver, pancreas, adrenals, and kidneys. The entire small intestine showed diffuse and extensive infiltration of the lamina propria by these cells, and the appearance was identical to that described in the surgical specimen of ileum. These changes were not present in the esophagus, stomach or colon. The bone marrow showed myeloid metaplasia.

Case II (No. 858753). This forty-three year

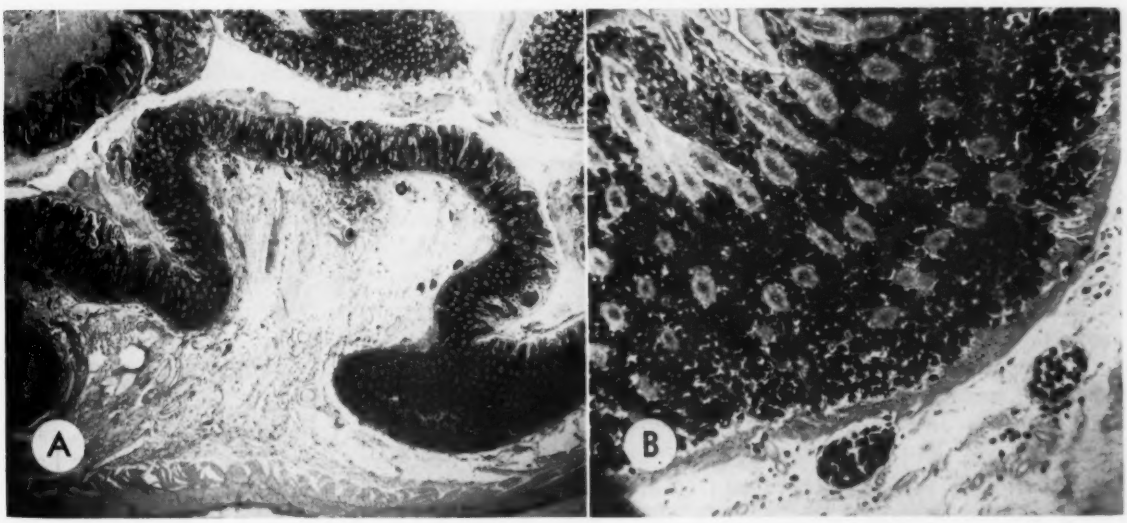

Fig. 4. Case I. Distal ileum, periodic acid Schiff stain. (*A*) The lamina propria is thickened due to infiltration by macrophages; the cytoplasm stains reddish purple. The submucosa is thickened due to edema and lymphangiectasia. The mucosal folds are widened. (14×). (*B*) Diffuse infiltration of the mucosa by periodic acid Schiff positive macrophages. Aggregates of similar cells in the dilated lymphatic vessels. (95×.)

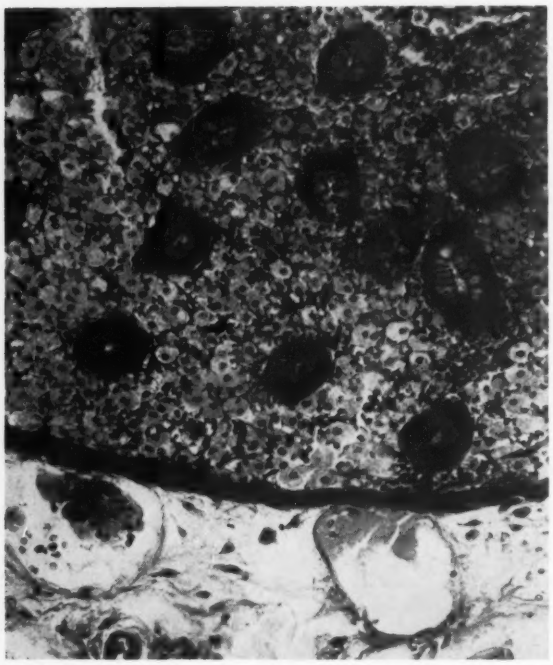

Fig. 5. Case 1. Distal ileum. Hematoxylin and eosin stain. Numerous macrophages, containing abundant granular cytoplasm, have infiltrated the mucosa. Dilated lymphatic channels are visible, one of which contains macrophages. (150×.)

old white female was admitted to the University Hospital in November, 1956 because of diarrhea which was constant for five months, except for two short periods of remission. In association with the sudden onset of diarrhea, she noted generalized, nonpainful lymphadenopathy, fever and cough. She developed weakness and complained of severe weight loss. The stools were never foul, frothy or bulky, but rather watery and at times pasty; there was no history of rectal bleeding. About one month prior to admission the lymph node enlargement and the daily febrile episodes disappeared spontaneously. She gave a history of migratory polyarthritis for three to five years prior to admission but none since March, 1956. She had 9 children, all alive and well. The medical histories of her parents and siblings were not significant.

There was evidence of marked weight loss. The blood pressure was 85/55 mm. of Hg, and pulse and temperature were normal. There was no abnormal skin pigmentation. Nontender, discrete enlarged lymph nodes were present in the neck, axillae and inguinal regions; they measured 1 to 2 cm. in diameter and were firm. The lungs were clear. The heart was not enlarged, and a Grade 1 systolic murmur was heard in the third left interspace. Examination of the abdomen was negative.

On admission the hemoglobin was 10.5 gm. per cent, red blood cell count 2.4 million. The leukocyte count was 5,000, with a shift to the left. Urinalysis was normal. The total serum cholesterol was 71 mg. per cent. The total serum protein was 7.8 gm. per cent with A/G ratio of 3.7/4.1. Fasting blood sugar was 86 mg. per cent, and an oral glucose tolerance test shortly after admission gave a blood sugar of 99, 116, 106, 78, 81 and 85 mg. per cent at one-half, one, one and one-half, two, three and four hours, respectively. Absorption studies performed on three occasions showed minimal reduction in intestinal absorption of fat and nitrogen.

Infiltration at the left base, seen on an admission chest roentgenogram, subsequently cleared. The colon was normal by barium enema study and sigmoidoscopy. A small bowel examination showed moderate thickening of the mucosal folds of the duodenum and jejunum (Fig. 6*A*). There was marked segmentation seen on a one and a half hour roentgenogram (Fig. 6*B*) and this was demonstrable in the ileum on later roentgenograms. Barium reached the cecum within five hours. The barium in the small bowel showed minimal coarse granularity and scattering of the barium occurred as the loops were evacuated. There was no roentgenographic evidence of rheumatoid arthritis.

Biopsy of a cervical lymph node showed moderate reticulo-endothelial hyperplasia; abundant P.A.S. positive material was seen within phagocytes. Exploratory celiotomy revealed a small amount of amber, clear ascitic fluid and a fibrinous exudate was present over the surfaces of the liver, stomach, colon and parts of the small bowel. The liver was judged to be twice normal size, as was the spleen; the latter was adherent to the diaphragm due to fibrous adhesions. The small intestinal wall appeared to be of normal thickness, but the wall was not transected. At the base of the thickened mesentery of the small bowel, there was a large group of discretely enlarged rubber-like lymph nodes. Biopsy of a mesenteric lymph node and omentum suggested Whipple's disease with P.A.S. positive material within typical macrophages. Duodenal mucosal biopsy, via the transoral route, showed the characteristic appearance of Whipple's disease.

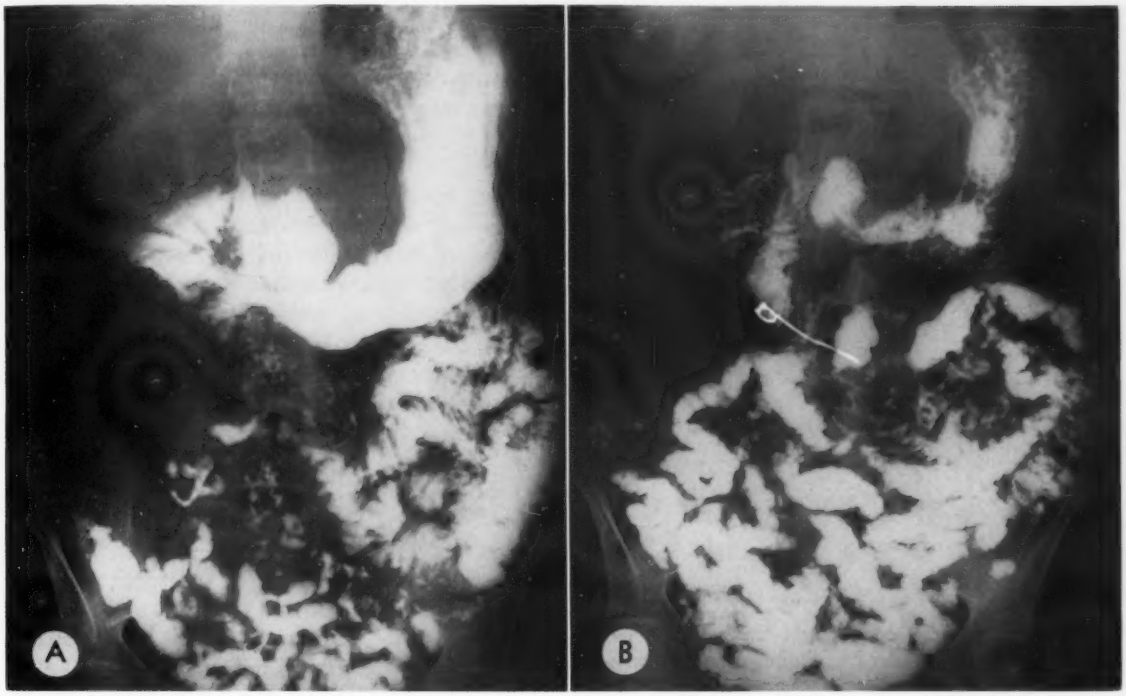

Fig. 6. Case II. (*A*) Thickening of the mucosal folds of the duodenum and jejunum at one-half hour following barium ingestion. (*B*) Segmentation of the barium at one and one-half hours.

In February, 1958, the patient complained of constant watery diarrhea and intermittent abdominal distention, of two months' duration. She gave a history of weight loss and anorexia. Physical examination revealed a thin female with marked evidence of wasting; the blood pressure was 110/66 mm. Hg, pulse 94, and body temperature 98°F. The lungs were clear, and the heart was not enlarged but there was a soft systolic murmur over the entire precordium. The abdomen was distended, and there was generalized tenderness to deep palpation. No masses or enlarged organs were palpable. Bowel sounds were hyperactive. Repeat small bowel series showed the previously described appearance.

Case III (No. 688748).* This patient was a fifty-four year old white male who entered the University Hospital in August, 1950 because of diarrhea which began seven months earlier. The diarrhea was intermittent at first, but during the two months prior to admission it had become more constant. The stools were generally loose, though formed at times; there were no foul or fatty stools, or rectal bleeding. He had occasional epigastric cramps and also vomited at times in the preceding few months. His appetite was poor, and he had lost 30 pounds in weight. There was no history of polyarthritis. The patient's mother and father were alive and well, as were his three siblings. He noted a lump in the right groin on two occasions in the previous two years, but this spontaneously regressed.

The patient appeared markedly cachectic. His blood pressure was 90/50 mm. of Hg and pulse and body temperature were normal. There was slight hyperpigmentation over the face, sacrum and bony prominences. A systolic murmur was heard at the cardiac apex. The lungs were normal. The abdomen was distended, and a mass, which was thought to be spleen, was palpable beneath the left costal margin. Cervical, axillary and inguinal lymph nodes were palpable but small.

Laboratory examination showed a hemoglobin of 8.1 gm. per cent, 3.7 million red blood cells and a normal white blood cell count and differential. Total serum cholesterol was 42 mg. per cent. The total serum protein was 5.3 gm. per cent, with A/G ratio of 2.7/2.6. Fasting blood sugar was 62 mg. per cent and glucose

* Only the salient clinical features and pathologic findings are given inasmuch as this case has been well documented in a previous publication.[44]

Fig. 7. Case III. Segmentation of the barium in the ileum at five and one-half hours after ingestion. There is coarse scattering of the barium in more proximal loops after evacuation.

tolerance test gave blood levels of 95, 75, 65 and 81 mg. per cent at one, two, three and four hours, respectively.

Roentgen examination of the gastrointestinal tract showed thickening of the valvulae conniventes of the proximal small intestine. Of two interval roentgenograms of the abdomen which were made following barium ingestion, the one at five and one-half hours (Fig. 7) showed segmentation of the barium column and scattering. Barium enema study was negative, as was sigmoidoscopy.

Biopsy of the left axillary lymph node did not yield a conclusive diagnosis. There were numerous aggregates of mononuclear macrophages. These cells showed a large amount of cytoplasm which was finely vacuolated. Occasional multinucleated giant cells of the Langhans type were seen. There was marked lymphoid and reticuloendothelial hyperplasia.

Approximately seven weeks after admission the patient became acutely ill with marked dyspnea. Blood pressure at this time was 60/40. A simple roentgenogram of the abdomen showed some dilatation of the colon but no evidence of mechanical obstruction. He expired in a state of shock approximately forty-eight hours after the onset of this acute episode.

Postmortem Examination. The body was markedly wasted and there was generalized cutaneous pigmentation. There were 3,700 ml. of straw-colored fluid in the peritoneal cavity; the serosal surfaces were diffusely adherent due to fibrinous adhesions. The left and right pleural cavities contained 400 and 800 ml. of straw-colored, fibrin-rich fluid, respectively. The pericardial sac was obliterated. The cardiac chambers were markedly dilated, and the heart weighed 350 gm. Verrucae were present on the atrial aspects of the mitral valve leaflets. Large polypoid vegetations were present on the tricuspid valve leaflets in a similar location. The colon was of normal size and contained semisolid feces and abundant thick mucus. The small bowel was of normal caliber and the wall was not thickened. The mucosal folds, however, were thickened and there was abundant thick mucus in the lumen. The mesenteric and retroperitoneal lymph nodes were enlarged, soft and yellow. The stomach and duodenum were normal.

Microscopically, the small intestinal villi were thickened and filled with large macrophages which were typical of Whipple's disease and gave a positive reaction to P.A.S. reagent. These cells were in the lamina propria, submucosa, and occasionally in the outer layers of the bowel wall. In addition, there were foci of purulent inflammation in the mucosa and the peritoneal surfaces showed a generalized subacute fibrinous reaction. The lacteals were dilated and filled with fat, and there were minute perivascular hemorrhages. The colon, in the region of the ileocecal valve only, showed similar aggregates of abnormal macrophages; the stomach was not involved. Mesenteric, retroperitoneal, and peri-aortic and bronchial lymph nodes were similar histologically to the axillary lymph node which was biopsied.

ROENTGENOLOGIC FINDINGS

Thickening of the mucosal folds was an outstanding feature in all of our cases and was most marked in the duodenum and jejunum. This is an understandable finding in the light of the pathologic changes. The most marked cellular infiltration is in the tunica propria of the small bowel where widening and clubbing of the villi results; the dilatation of the lymphatics and the submucosal edema also contribute to the widening of the valvulae conniventes. The

mucosal folds are normally widest in the proximal small bowel and one would expect the greatest thickness to occur in this portion.

Thickening of the mucosal folds in idiopathic sprue may be observed, but the mechanism of its production is not clear in the light of the usual findings of flattening of the mucosal villi and thinning of the bowel wall; the degree of cellular infiltration has been minimal. It is possible that mucosal and submucosal edema, not reflected in necropsy findings, has been responsible. Possible overactivity of the muscularis mucosae has also been suggested. Nevertheless, marked thickening of the mucosal folds, as was here demonstrated, has not been seen in the majority of cases of sprue.

The "moulage sign" was first pointed out by Kantor[24] and refers to the apparent obliteration of the mucosal folds in the jejunum, presenting the lumen as smoothly contoured by the barium, as if wax had been poured into it and allowed to harden. Although this is more in keeping with what one might expect to find in sprue, it is seen in few of the cases and usually in the more advanced ones.[29] It was not seen in any of our cases.

The average normal width of the lumen of the small intestine has been given as 2 to 3 cm.[11] It is recognized that such measurements have limited value because variations in muscle tone, as well as in the speed and extent of barium filling, can produce wide differences in caliber; such variations in tone are seen in the jejunum rather than the ileum. It is frequently difficult to judge the significance of minimal widening of the lumen.

Minimal dilatation was present in Case 1 but was absent in the other 2 cases. This is noteworthy inasmuch as dilatation is an important and frequently marked change in idiopathic sprue. Using balloon techniques, Ingelfinger and Moss[22] showed that in sprue the gut lacks the usual degree of resistance to distention, and at autopsy one frequently finds thinning and sacculation of the small bowel wall. Whether the thinning of the wall is a cause or effect of dilatation is not clear. The gut wall usually is thickened in Whipple's disease. The colon may be chronically dilated in sprue; we have observed the colon to revert to normal caliber within four months in a well-documented case of sprue treated with a gluten-free diet. It is not clear whether such dilatation is due to bulkiness of the stool or lack of tone in the wall. At necropsy the colon is not found to be abnormal in Whipple's disease, which is in keeping with roentgenologic findings.

Snell and Camp,[40] in describing the roentgen findings in idiopathic steatorrhea, referred to a tendency of the barium to clump in elongated masses. This was an important and conspicuous finding in all of our cases. It was most prominent in the ileum but was apparent as well in the jejunum in Case 1. The segments were at least as wide as the normal caliber of the bowel at that point and were distinctly separated from one another. In this respect the appearance differed from that seen in the hypertonic bowel pattern. To be sure, small contracted worm-like segments of barium were present, too, but these did not predominate nor was the transit time unusually rapid. The segmentation was identical and not less marked than that seen in idiopathic sprue.[29]

Segmentation, frequently alluded to in radiologic writing, is a little understood finding. While the idea that it is due to a damaged intramural nervous sytem[13] has received little pathologic support, balloon studies[22] have suggested that the nervous apparatus of the small intestine fails to liberate acetylcholine in sprue. The role of muscle damage has been emphasized[42] and related to the frequency of observed segmentation seen in normal infants, due possibly to modified muscular action. Golden[13] has stressed nutritional deficiency as an important factor, but it is generally agreed that the lack of certain vitamin B complex components[15,18] is not always present when small bowel segmentation is demonstrable.

It has been shown that segmentation can be induced in normal individuals by the addition of fatty acids or hypertonic solutions, or mucus, to the barium.[8] It was concluded that segmentation was due to the action of intestinal mucus on the barium and that enteric irritants produce segmentation because they stimulate an excess production of mucus secretion. On this basis, one can easily explain the segmentation in the cases we have presented. As in sprue, unabsorbed fatty acids act as irritants, causing excessive mucus secretion. It is possible, too, that there is a primary overproduction of an abnormal intestinal mucus in Whipple's disease. However, if the mechanism depends on the presence of a chronic irritant within the enteric stream, one might expect to find more of the hypertonic contracted segments and a consistently short transit time. Furthermore, segmentation persists in patients with a long history of sprue who are in clinical remission. Does this mean that in these cases there is still an excessive production of intestinal mucus? One must also explain why patients with pernicious anemia and neuropathy, as well as those with diabetic neuropathy, who do not have steatorrhea, may exhibit a segmentation pattern.[20] Disturbance in peristalsis, with lack of coordinated contraction and relaxation in the face of a highly irritant bowel content is an attractive theory. In sprue, such muscular insufficiency is due to atrophy of the bowel wall. Extensive infiltration and congestion in the wall of the small bowel, as is seen in Whipple's disease, might impart sufficient rigidity to interfere with normal peristalsis. One could thus implicate some degree of mechanical interference with muscular function of the bowel in the presence of chronic irritation. However, one may question the importance of such a mechanism in the face of a normal transit time and lack of involvement of the tunica muscularis.

A granular coarsening in the appearance of the barium within the filled loops is regarded as evidence of admixture with secretions. When this is marked, the barium may become flocculated in irregular fashion within the opacified loops. This finding was moderately prominent in Case I but not in Cases II and III. The effect on a given barium mixture will depend on the quality of the secretions, as well as the quantity and distribution. A coarse scattering of the barium was noted after the intestinal loops emptied. It is probable that this is related to increased mucus secretions and represents the floccules of barium residual on the wall of the gut as the bulk of the barium is evacuated. This phenomenon in lesser degree may be observed in normal subjects and is to be expected in that the normal mucosa is coated with a small amount of intestinal mucus.

The transit time signifies the interval required for the head of the column of barium to reach the cecum and is only one method of estimating intestinal motility; there is a wide range of normal values.[28] The transit time will vary with the type and quantity of barium used and may differ in the same normal individual from one examination to the next. In our experience, the average transit time, using ordinary U.S.P. barium sulfate suspension in tap water, is approximately three hours when 16 to 18 fluid ounces are used to examine the small bowel. The transit time was normal in all 3 of our cases. This finding is significant in view of the lack of involvement of the tunica muscularis. Chronic hypomotility, as might be seen in amyloidosis, scleroderma or advanced cases of idiopathic sprue, probably does not occur in Whipple's disease.

DIFFERENTIAL DIAGNOSIS

Various conditions are capable of producing alterations in the roentgenologic appearance of the small intestine which are indistinguishable from Whipple's disease. It will usually be necessary to rely on the clinical and laboratory data in the differential diagnosis. Even if positive identification may not be possible on roentgen evidence alone, the recognition of certain abnormal features may serve to strengthen

the likelihood of a particular diagnosis.

Chronic dilatation of the small bowel, and often the colon too, is an important and often marked feature of idiopathic sprue, but was not a prominent finding in our cases. Furthermore, a macrocytic anemia which is characteristic of sprue has not been reported in any of the cases of Whipple's disease.[33] Mucosal fold thickening may be seen in both conditions and was marked in all of our cases, but thus far, the moulage phenomenon has been described only in sprue. Segmentation, flocculation and scattering are seen in both conditions. Severe fluid retention in the small intestine is probably more characteristic of sprue. In pancreatogenous steatorrhea there may be slight dilatation and segmentation, but characteristically, the changes are not profound and small bowel appearance is frequently normal.[1,21]

Several cases of involvement of the small bowel by amyloidosis have been described.[12,14,25] In cases where the tunica muscularis is involved, one may expect to find dilatation of the small bowel and stasis of the barium as the most significant features. Thickening of the valvulae conniventes may be marked and has been described in cases where amyloid has been extensively deposited in the mucosa and submucosa.

Involvement of the alimentary tract may occur in scleroderma, producing hypomotility and dilatation due to replacement of muscle with fibrous tissue. In the small intestine these changes are usually confined to the jejunum, although they have been known to extend into the ileum as well. Segmentation and thickening of the mucosal folds have not been described. The esophagus is almost always involved at the time changes are detected in the small bowel.

Long ulcerated stenotic segments of bowel, usually the terminal ileum, are commonly observed in the later stages of regional enteritis. In the early phases of this disease, the valvulae may be thickened, but, in addition, the bowel loops are straight, rigid and separated from one another due to increased wall thickness and thickened mesentery. Segmentation is not characteristic of regional enteritis; neither mucosal ulceration nor partial intestinal obstruction are observed in Whipple's disease.

An uncommon form of lymphosarcoma is predominantly characterized by diffuse invasion of the mesentery, closely resembling the roentgen findings encountered in Whipple's disease. There may, however, be evidence of extraluminal masses with resultant displacement of small bowel loops or large neoplastic filling defects in the barium column. The variety of appearances which lymphosarcoma may present have been well summarized.[30] Localized thickening of the mucosal folds due to lymphosarcomatous infiltration of the wall of the bowel is not to be confused with generalized mucosal thickening seen in the mesenteric form of lymphosarcoma and in Whipple's disease.

Moderate dilatation of the proximal small bowel has been described following subtotal gastrectomy and a sprue-like pattern has been observed when the surgical procedures included vagotomy.[9] These changes are transient and occur in the immediate postoperative period.

CECAL VOLVULUS

The term cecal volvulus is a misnomer for the torsion almost always involves the distal ileum or part of the ascending colon. In order for cecal volvulus to occur the cecum and ascending colon must be abnormally mobile in sufficient degree to permit rotation about an axis provided by some adjacent fixed point. The fixed segment may be the ascending colon or the terminal ileum. Sometimes the entire ascending colon is mobile. Mobility of the right side of the colon depends on failure of fixation to the posterior abdominal wall and may be associated with an abnormality of rotation and failure of descent. The final adult position of the cecum is not attained until about four months after birth.[16]

Wolfer *et al.*[46] reviewed the peritoneal attachments in 125 cadavers and found that in 11.2 per cent the cecum was sufficiently mobile to permit the development of volvulus. Sweet[43] gives the incidence of cecal volvulus as the cause of intestinal obstruction as 1.2 per cent, based on 520 cases; 11 per cent of all the cases of volvulus were of the right side of the colon. It is evident that there must be an inciting factor, in addition to the lack of adequate peritoneal attachment, in order for torsion to occur. Among the factors which have been incriminated are diarrhea, chronic colonic dilatation and mechanical displacement of the colon.

Recently, 4 cases of volvulus of the colon as a complication of idiopathic sprue were presented.[10] The sigmoid was involved in 2 cases and the cecum in one; in the fourth case there was an obstruction at the splenic flexure, the nature of which could not be determined at autopsy. The authors thought that in these cases the development of volvulus was due to chronic dilatation of the colon seen in sprue.

We have not found any previous case report of colonic volvulus in Whipple's disease. It is quite possible that in this case the finding is coincidental. Of interest was the finding of a mobile, medially deviated cecum on barium enema examination two months prior to the development of volvulus. One may speculate that the inciting factor was the irritation produced by the fecal stream which contained blood and fatty acids. It is also possible that peritoneal irritation may have resulted in acute dilatation of the bowel immediately preceding the onset of volvulus.

DISCUSSION

The clinical findings in these three histologically verified cases of Whipple's disease closely parallel those described in the literature.[5,32,33,35,36] Intestinal malabsorption was profound and well documented in Case I but was not marked in Case II; this aspect was not sufficiently studied in Case III, but the oral glucose tolerance curve was "flat." Serum albumin and cholesterol were uniformly low, consistent with the poor state of nutrition. A history of polyarthritis, prior to the onset of intestinal complaints, was elicited in 2 of the patients, and all 3 complained of intermittent diarrhea and abdominal pains. Intestinal bleeding was documented in 2 patients, and abnormal skin pigmentation in 1. Enlargement of peripheral lymph nodes was a feature in all 3 cases; the systolic blood pressure was less than 100 mm. of Hg in 2. Few cases have been described in females, and from this point of view, the second patient is of interest. There was nothing in the case histories to incriminate a hereditary factor in the etiology.

With regard to the roentgenology of the small bowel, it is difficult to compare our findings with the observations of others; few authors have described more than one case, and, furthermore, there has been an unfortunate tendency to speak of the roentgen changes in general terms, such as "deficiency pattern," and "motor dysfunction," rather than to provide meaningful detailed descriptions. The problem of precise description is also complicated by the variety of techniques which are used to examine the small bowel. Important factors to note are the type and quantity of barium used, the frequency of interval filming and the completeness of the examination. In the presence of abnormal findings, it is frequently desirable to repeat the examination for confirmation. At the University Hospital we use U.S.P. barium sulfate in tap water suspension in the ratio of approximately 1:2 by weight; the mixture is proportioned by measurement of the specific gravity.

Cases I and II received 16 to 18 ounces of barium suspension and roentgenograms were taken at one-half to one hour intervals until the cecum was visualized; both cases were examined more than once. The roentgen findings supported the clinical suspicion of Whipple's disease. Roentgenologic study of the third patient was not as complete. He was given 8 ounces of barium

and only two interval roentgenograms of the abdomen were made. Although attention was called to the abnormal findings, their significance was not appreciated during the life of the patient.

Marshak *et al.*[29] have suggested that in idiopathic sprue the abnormal small bowel pattern is sufficiently distinctive to separate it from a variety of other conditions which radiologists have frequently been content not to differentiate. The roentgen findings in these 3 examples of Whipple's disease indicate that one can expect the small bowel appearance to be profoundly abnormal. Thickening of the valvulae conniventes of the duodenum and jejunum is a conspicuous feature. Segmentation of the column into large, separated masses of barium was consistently observed. The absence of the degree of dilatation usually seen in idiopathic sprue and the lack of significant fluid retention in the small bowel are noteworthy points. Hypomotility was not observed.

SUMMARY

1. The clinical, pathologic and historical features of Whipple's disease are briefly reviewed.

2. The roentgen findings in the small intestine in 3 proved examples are described in detail and comparison is made with other small bowel diseases.

3. A complication of cecal volvulus is reported.

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A ROENTGEN SIGN OF GANGRENOUS APPENDICITIS

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GAS in the appendix is a relatively uncommon finding which is surprising in view of the large number of air-contrast enema examinations being performed. In the appendix which is normal in location and in every other respect, only occasionally is an inconstant air collection seen. Figure 1 is a cholecystogram demonstrating an air and teridax-filled appendix which was proved normal on subsequent laparotomy. On barium enema study with air contrast done two days later, this appendix did not fill.

When the appendix lies in the right upper quadrant and represents the highest point of the right colon, it is in many instances constantly filled with air (Fig. 2).[3] This does not signify disease.

With cecal distention as the result of ileus, the appendix may be air-filled (Fig. 3). Frimann-Dahl[2] has an excellent illustration of this but does not discuss it. We have not seen air-fluid levels in cases of this type.

FIG. 1. Air and teridax in normal appendix.

FIG. 2. Air in subhepatic appendix.

The gas-filled appendix as a sign of appendiceal disease has not, to our knowledge, been previously documented. Samuel[3] mentions that this may occur in the presence of an obstructed appendix infected with a gas-forming organism, but cites no examples. Steinert *et al.*[5] do not describe it in their discussion of 104 cases of appendicitis.

REPORT OF A CASE

A seventy-six year old man, unable to give a satisfactory history, presented himself at the Philadelphia Veterans Administration Hospital complaining of right lower quadrant pain. The initial examination disclosed no positive physical signs. A few hours later there was some tenderness and guarding in the right lower quadrant, but no rebound tenderness. The temperature was 97.6° F., the white blood cell count 14,600 with a shift to the left. The roentgen findings are illustrated in Figures 4 and 5.

Fig. 3. Mechanical ileus due to sigmoid carcinoma with air in appendix.

Fig. 4. Gas in dilated appendix in gangrenous appendicitis.

Fig. 5. Decubitus view showing fluid level and fixation of appendix.

The operative diagnosis was acute gangrenous appendicitis, not perforated, with the appendix adherent to the cecum posterolaterally. No cultures were reported.

The striking roentgen findings, by which the correct diagnosis was made preoperatively, were a dilated fixed appendix containing gas and a fluid level, in the absence of marked colonic ileus. This is quite distinct from the extraluminal gas bubbles seen in perforated appendix or appendiceal abscess.[1,4,6]

CONCLUSIONS

1. The normal appendix contains gas only transiently and occasionally.
2. A constant gas collection, without fluid level, may be seen in the subhepatic appendix, or with marked cecal distention.
3. A dilated fixed gas-filled appendix with a fluid level has been described as a sign of gangrenous nonperforated appendicitis.

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ROENTGEN CHANGE IN DISEASE OF THE APPENDICES EPIPLOICAE*

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MOST surgeons are familiar with acute disease of the appendices epiploicae, but the condition is relatively unknown to radiologists. Although 102 cases were collected in the surgical literature in 1953,[6] no report is found in the American radiologic literature concerning acute afflictions of these structures. Inasmuch as the diagnosis is practically always made only at the time of celiotomy for a "surgical abdomen," few patients have had preliminary roentgenographic studies with barium. We have been able to collect 7 cases proved at operation, 3 of which showed significant abnormalities on barium enema studies. In a fourth case, a survey roentgenogram of the abdomen permitted the diagnosis to be suggested preoperatively.

ANATOMY

The appendices epiploicae of the colon are present as early as the fifth fetal month. They are pedunculated fat pads continuous with the subserosal fat and are covered by visceral peritoneum from the colon (Fig. 1). Their average size is 3 cm. but they vary from 0.5 to 5 cm., and have been reported up to 15 cm. in length. They are longest in the sigmoid colon. About 100 of these appendages are usually present and their size and shape varies with the state of nutrition, being larger in obese individuals. They are found over the entire colon, from the cecum to the upper rectum, and occasionally on the vermiform appendix, but they are most abundant in the transverse and pelvic colon. They occur quite evenly in two rows, one being situated on the anterior and one along the posterior muscle bands.[15] Occasionally, they may occur in three rows, and less often in one row.

PHYSIOLOGY

The function of the appendices is obscure. Pines *et al.*[15] believed that the fat pad acts as a safety mechanism for the redundant U-shaped blood vessel within it when the intestinal wall is collapsed, and prevents compression and obliteration of its lumen when the bowel is distended. Patterson,[14] in a careful anatomic and pathologic study, reached somewhat similar conclusions con-

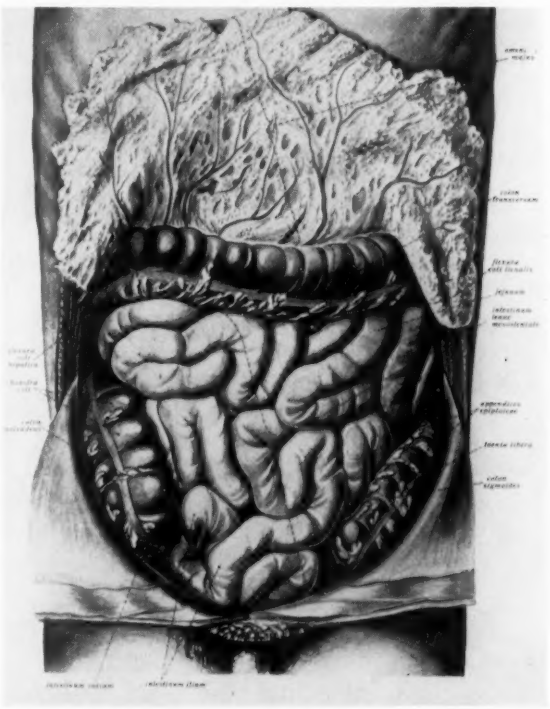

Fig. 1. Anatomic drawing showing relation of appendices epiploicae to colon. (Reproduced by permission from Sobotta's Atlas of Descriptive Human Anatomy.)

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cerning the protective function of the appendices epiploicae. The vessels of the colon appear as inverted U-shaped loops in the appendices, giving off branches to the respective appendix and bowel wall. The appendices protect the vessels when they become lengthened in the collapsed state of the bowel. Klingenstein[9] believed that their function is probably related to that of the omentum because of a similarity in structure and therefore they act as a protective barrier against the spread of intra-abdominal infections. They may also be concerned with the movement and absorption of fluid and the storage of fat. Too, they act as a protective buffer during peristaltic movements.

PATHOLOGY

The appendices epiploicae may become involved in 6 different pathologic states, according to a review of 102 cases collected from the literature by Fieber and Forman:[6] (1) Torsion occurred in 31 per cent of the cases; (2) thrombosis and infarction in 15 per-cent; (3) gangrene in 20 per cent; (4) acute inflammation and suppuration in 19 per cent; (5) chronic inflammation (replacement by fibrous connective tissue, hyalinization and calcareous degeneration) in 14 per cent; (6) intussusception in 1 per cent.

The cause of torsion of the appendices is unknown, but Patterson[14] believes it occurs because of the fact that the vein is longer than the artery and gradually takes up a tortuous course around it, and, for reasons of hemodynamics, this is thought to facilitate torsion. Another factor may be the relative plethora of the fat laden appendices epiploicae during the phase of vascular congestion that accompanies digestion, which may increase their tendency to twist. Torsion is also believed to occur as the result of movement of adjacent coils of small bowel during vigorous peristalsis associated with large appendices epiploicae on a long pedicle.[12] A number of cases have been reported of torsion of an appendix epiploica on a loop of colon as it twists in its passage through the inguinal or femoral ring.[8] This is also the most common site for mechanical interference by direct pressure and strangulation without torsion. Some of the infarctions in which torsion is not demonstrated might possibly occur as a result of embolism or vascular thrombosis. Multiple infarcts of appendices epiploicae as a result of torsion or thrombosis may lead to stenosis of the lumen of the bowel from constricting fibrosis. Interference with circulation can be acute or chronic, the latter giving rise to fat necrosis, saponification of fat, fibrosis and perhaps even calcification. The calcified appendage may even separate from the bowel wall and form a foreign body in the peritoneal cavity, the so-called "corpora aliena adiposa" or peritoneal loose body.[1,8] In acute cases one may observe hemorrhage into fatty tissues, hemorrhagic gangrene or free hemorrhage into the peritoneal cavity.[6] The hemorrhagic or gangrenous mass may become infected by bacterial invasion from the bowel. The organizing hemorrhage and resolving infection may give rise to adhesions which can obstruct either the small or large bowel.[11,13] Some have noted the frequent association of diverticula in the immediate vicinity of the appendices epiploicae, and believe this may be due to the relationship of the appendix epiploica with the point where the larger vessel of the appendix enters the intestinal wall. This point where the appendiceal vessel enters may result in a weakness in the wall, prediposing to diverticulum formation. In some cases of acute diverticulitis, it has been found that one or more appendices epiploicae may be hard, hemorrhagic and partially necrotic.

CLINICAL FEATURES

The clinical signs and symptoms of disease of the appendices epiploicae are usually those of an acute surgical abdomen. The most characteristic signs are present when an inflamed mass is in contact with the parietal peritoneum. Pines and his coworkers[15] felt that hyperesthesia of the skin area was a prominent symptom. When

an appendix epiploica in the cecal area is involved and the vermiform appendix has been previously removed, the diagnosis can be tentatively made. The presence of a tender small mass is also suggestive. Murdie[13] states that the diagnosis is rarely possible except in 4 conditions: (1) Where the scanty findings are paradoxical as related to the degree of subjective complaints. A patient who normally bears pain well complains bitterly in the face of minimal signs. (2) When a mass is found in relation to the colon with no history to suggest diverticulitis, carcinoma of the colon, cholecystitis or ovarian disease. This occurs in chronic cases where time can be spent in investigation of the patient. (3) When the picture is that of appendicitis but the appendix has been previously removed. (4) When there is disproportion between the abdominal tenderness and rigidity and the duration of symptoms. There is marked tenderness with little or no guarding where, from the duration of the disease, marked guarding would be expected.

The differential diagnosis runs the usual gamut of appendicitis, diverticulitis, cholecystitis, enterocolitis, torsion of ovarian cyst, strangulated hernia, intestinal obstruction, mesenteric thrombosis, neoplasm of the bowel, etc. Changes may occur without symptoms and this accounts for the cases found at autopsy.

While diseases of the appendices epiploicae are relatively uncommon, they are important enough so that the surgeon entering the acute abdomen should recognize their existence when encountered. If the appearance of the vermiform appendix during surgery does not explain the patient's symptoms, then disease of the appendices epiploicae should be considered, since occasionally death can result from their involvement, 4 cases having been reported.[6] In some of the reported cases, this has necessitated a diligent search by the surgeon to explain the symptoms in what appeared at first to be a normal abdomen at operation. While the diagnosis has been made preoperatively by at least Wakely and Childs,[17] Eliason and Johnson,[5] and Babcock,[7] this is not generally possible.

ROENTGEN FEATURES

Roentgen changes have not to our knowledge been described in the American literature in acute and subacute disease of the appendices. Barden[1] reported on a late sequela of disease of these structures, 2 cases of calcified loose bodies being encountered by this author. Fieber and Forman[6] described the changes encountered by di Rienzo and Mosca[3,4] on barium studies as representing disease of these structures, but the process reported by these authors appears to us to represent omentitis rather than disease confined to the appendices epiploicae. Poirier[16] described a case in the French literature in which there was roentgenographic evidence of constriction of the terminal portion of the ileum caused by an inflamed appendix epiploica of the sigmoid colon. In the British literature Le Vay[10] described a case of torsion and inflammation of a sigmoid appendix epiploica in a well nourished individual with a 15 month history of left lower quadrant pain. Barium enema studies showed spasm and some narrowing over 2 to 3 inches of the sigmoid with a loss of haustrations and a deformity at one point rather suggestive of a diverticulum. Surgery revealed the true nature of the disease process.

MATERIAL

We have encountered 7 cases of diseases of the appendices epiploicae which exemplify the various problems which may occur. Roentgenographic findings have been clear-cut and positive in 2 cases and suggestive in 2 others. The experience derived in one case permitted the surgeon to suggest the correct diagnosis preoperatively in one of the subsequent cases. The remaining 3 cases were too acute for roentgen examination. These 7 cases may be classified as follows:

A. With roentgen changes: (1) Barium enema examination showing constriction

of sigmoid suggestive of carcinoma; (2) barium enema examination showing intramural defect suggestive of a benign tumor; (3) barium enema examination showing spasm of sigmoid associated with small bowel distention resembling obstruction or localized ileus suggestive of "sentinel loop," with a clinical picture resembling that of diverticulitis.

B. Without roentgen changes: (1) Typical picture of acute appendicitis; (2) involvement in an incarcerated hernia.

REPORT OF CASES

CASES WITH ROENTGEN CHANGES

Case I. (Simulating carcinoma.) A forty-six year old white female (JK) had left lower quadrant pain for one week. There was associated constipation despite an urge to move her bowels. Vomiting occurred once. Examination revealed an evanescent soft cystic mass first in the left upper quadrant and again in the left midabdomen. Sigmoidoscopy was normal up to 6½ inches, beyond which further penetration was not possible. Laboratory findings were normal.

Initial roentgenograms showed dilated loops of large bowel concentrated in the left lower abdomen almost like a volvulus. An immediate barium enema study (Fig. 2) revealed a short, narrowed segment in the rectosigmoid region with rather marked narrowing of the lumen and some shelving of the margins. Satisfactory mucosal markings could not be seen in the area of narrowing. The colon proximal to the narrowed segment was dilated and the examination was discontinued. Following evacuation, the rectum emptied itself of barium with some barium being retained in the segment proximal to the obstruction. The findings were consistent with an annular carcinoma of the rectosigmoid.

The obstructive symptoms were overcome with enemata. Subsequent to this the mass disappeared completely. After appropriate bowel preparation, surgery revealed a loop of sigmoid to be completely encircled by an elongated appendix epiploica, the tip of which was adherent to the sigmoid near its point of origin so that a sling was formed through which the bowel loop had slipped and had become incarcerated. Pressure by the appendix epiploica had so grooved the distal portion of the loop as to give the annular effect of a carcinoma of the sigmoid. The evanescent mass was the distended trapped loop of bowel before the obstruction was relieved. Therapy simply consisted of removal of the offending appendix epiploica.

Case II. (Simulating intramural sigmoidal pathology—Dr. Leon Manheimer.) A forty-three year old white male (SK) complained of left lower quadrant dull pain of two weeks' duration gradually becoming more severe. There was no change in bowel habits nor were there other gastrointestinal complaints. Examination disclosed only slight tenderness in the left lower quadrant. Barium enema examination (Fig. 3) revealed a bilobular smooth filling defect on the anterolateral wall of the proximal sigmoid colon, seen only in the oblique view. There was no associated irritability of the bowel. The appearance was that of an extrinsic lesion of the colon. The possibility of an extramucosal tumor of the bowel such as intramural leiomyofibroma was considered. At surgery, a twisted gangrenous appendix epiploica 2 cm. in diameter was found adherent to the anterior wall of the sigmoid. The sigmoid mesentery was edematous, adhered to the parietal wall, and contained numerous filmy adhesions which extended to and partially around the bowel wall. Therapy involved removal of the offending appendix epiploica.

Case III. A thirty year old white male (WB) developed progressively severe lower abdominal pain which settled in the left lower abdomen. Vomiting occurred twice after the onset. The clinical picture was typical of acute diverticulitis with signs of left lower quadrant peritonitis, leukocytosis, and some distention. Roentgenograms of the abdomen showed dilated loops of small bowel without fluid levels in the left abdomen. Barium enema examination (Fig. 4) revealed a marked degree of spasm of the sigmoid colon with edema of the mucosal folds and no demonstrable diverticula. After forty-eight hours of observation, the small bowel loops became more distended, and surgery was advised. The preoperative diagnosis was inflammation of Meckel's diverticulum adjacent to the sigmoid colon causing spasm of the latter. Operation revealed an inflammatory mass adherent to the sigmoid, bluish in color. After dissecting it away from the bowel, it was found to be a gangrenous appendix epiploica, the size of a man's thumb. It was resected. The small bowel in the left abdomen was moderately distended but otherwise uninvolved. There was

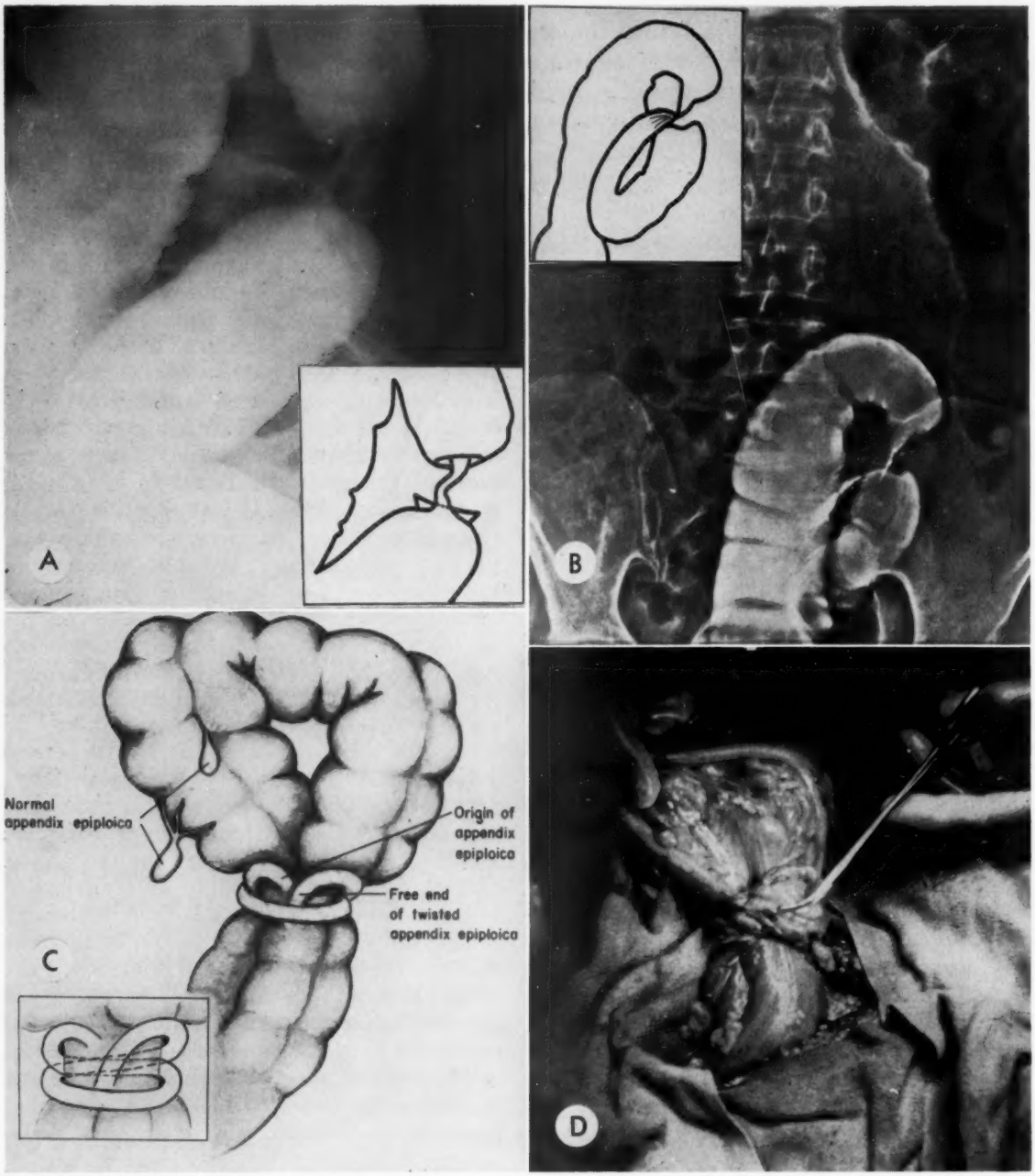

Fig. 2. Case 1. Twisted appendix epiploica of sigmoid colon simulating carcinoma. (*A*) Obstructing lesion with overhanging edges. Insert: line drawing reveals proximal point of obstruction obscured by superimposed distal obstruction of closed loop. (*B*) Postevacuation roentgenogram separates the two points of obstruction to some degree. (*C*) Artist's drawing of operative findings, with insert showing course of the twisted appendix in what amounts to a clove hitch knot. (*D*) Photograph taken at surgery. The obstructed closed loop has been lifted out of the abdomen and rotated upward 180°. Hemostat points to twisted elongated appendix.

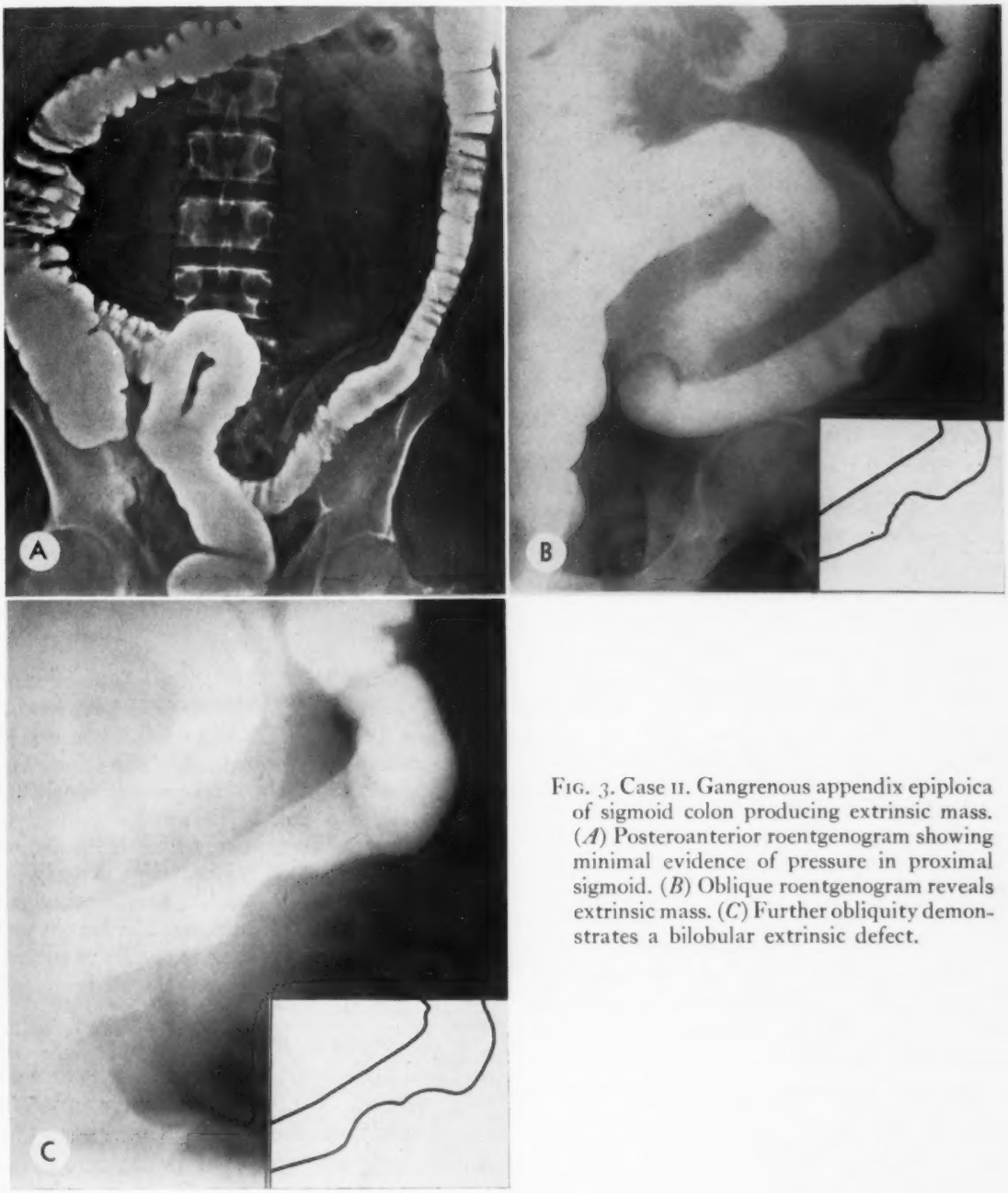

Fig. 3. Case II. Gangrenous appendix epiploica of sigmoid colon producing extrinsic mass. (*A*) Posteroanterior roentgenogram showing minimal evidence of pressure in proximal sigmoid. (*B*) Oblique roentgenogram reveals extrinsic mass. (*C*) Further obliquity demonstrates a bilobular extrinsic defect.

considerable clear fluid in the peritoneal cavity. The artery and vein in the specimen were thrombosed without torsion.

Case IV. A fifty-two year old white male (JHC) complained of left lower quadrant pain, severe enough to warrant intravenous pyelography in search of a left renal calculus. The pain had been present for four days and two successive survey roentgenograms of the abdomen showed increasing small bowel distention. Anorexia and nausea with constipation were the only other symptoms. Examination revealed moderate left lower quadrant peritonitis, well localized, with diffuse abdominal distention with hypoactive peristalsis. Laboratory studies of an exhaustive nature were negative. One year previously a barium enema study was negative and a review of the roentgenograms showed no evidence of diverticulosis. Surgery was advised

Fig. 4. Case III. Gangrenous appendix epiploica of sigmoid colon revealing marked spasm of sigmoid with edema of the mucosal folds.

because of the local findings in the abdomen, the increasing small bowel distention, and the belief that diverticulitis was probably not present. Because of the similarity to Case III, a preoperative diagnosis of gangrenous appendix epiploica with secondary small bowel distention was entertained by the surgeon. At operation a gangrenous appendix epiploica was discovered adherent to the lateral peritoneal wall. The adjacent small bowel had large inflamed lymph nodes in its mesentery and the bowel proximal to this point was markedly distended. Recovery was prompt following the removal of the appendix epiploica. Five months later the patient had a similar but milder episode which his physician treated conservatively. It lasted five days and subsided spontaneously. It was suspected that another appendix epiploica of the sigmoid had become inflamed but subsided spontaneously without any complications in a few days.

CASES WITHOUT ROENTGEN CHANGES

Case V. (Simulating typical episodes of acute appendicitis—Dr. Stanley Frehling.) A thirty-four year old white female (BG) complained of right lower quadrant pain and nausea of twenty-four hours' duration. Examination revealed typical localized peritonitis in the right lower abdomen of a mild degree. Initial white blood cell count was 9,000 and temperature was normal. During the next twelve hours the white blood cell count rose to 17,500. Temperature rose and the local findings increased. Laparotomy with a preoperative diagnosis of acute appendicitis revealed a normal appendix but adherent to the ascending colon was a mass which proved to be a twisted gangrenous appendix epiploica. Resection of the gangrenous appendix was followed by uneventful healing.

Case VI. (Simulating typical episodes of acute appendicitis—Dr. Stanley Frehling.) A thirty-five year old white female who was five weeks post partum had a five day episode of lower abdominal cramps which for the previous twenty-four hours had localized in the right lower quadrant. Typical localizing signs of right lower quadrant peritonitis were associated with a leukocytosis of 16,200. Surgery revealed an injected small vermiform appendix but in the mid-ascending colon there was a gangrenous long appendix epiploica with its tip adherent to another appendix epiploica, which also had a reddened tip because of its proximity to the gangrenous one. Both of these and the vermiform appendix (Fig. 5) were removed without incident. The vermiform appendix on pathologic examination was found to be involved in a periappendicular inflammation, secondary to the primary pathology.

Case VII. (Involvement in an incarcerated hernial sac.) A fifty-two year old white male was seen because of a large left incarcerated inguinal hernia of several hours' duration. The hernia was reduced but the patient continued to have signs of left lower quadrant involvement. Surgery the next day revealed a sliding hernia of the sigmoid colon and an acutely inflamed sigmoidal appendix epiploica which was causing the physical signs. The hernia was repaired and the offending appendix removed.

DISCUSSION

It is unlikely that one would ever be justified in making a diagnosis of torsion or gangrene of the appendices epiploicae based solely on the roentgen findings. The clinical importance of the pathologic process lies not in the preoperative diagnosis but in being aware of its existence and in being able to recognize it once the abdomen is entered. The usual dearth of accompanying clinical information also further militates against suggesting the diagnosis. However, with adequate findings or close surgical correlation, involvement of these structures can be considered in those cases which are not too acute and in which opportunity exists for barium enema studies. Spasm and

Fig. 5. Case VI. Inflamed vermiform appendix and gangrenous appendices epiploicae. Surgical specimens reveal an injected vermiform appendix on the left, an appendix epiploica in the center with a tip reddened by proximity to the gangrenous appendix epiploica on the right.

irritability of the bowel, when seen for the first time in the absence of diverticula, amoeba and other parasites, or specific extracolonic intra-abdominal pathology, should raise the possibility of disease of the appendices epiploicae. It is quite probable that many cases subside after one attack, never to recur. Functional disease of the colon will usually show multiple intermittent areas of spasm with a long history of recurrence of symptoms.

The confusing roentgen appearance in Case I mimicking a neoplastic lesion can be appreciated in the light of the operative findings and the artist's drawing of the photograph taken during surgery. The barium enema roentgenograms (Fig. 2) suggested that the barium had flowed beyond a single point of obstruction exhibiting overhanging edges. Actually two points of obstruction existed which were superimposed and produced a closed loop. This was better illustrated in the postevacuation study, where the areas of obstruction were slightly separated. The barium passed the distal obstruction, filled the closed loop, but never went beyond the proximal obstruction.

The extraluminal changes seen in Case II could be secondary to disease in the neighboring pelvic organs, but in the male, the diagnostic possibilities are more limited. An abscess due to foreign body perforation or even due to perforation of a solitary diverticulum would have to be considered. Congenital anomalies such as localized reduplication of the bowel or pressure from a Meckel's diverticulum could produce this appearance. Lymph node enlargement due to infection or malignancy could also produce extrinsic pressure. Disease of the uterus, adnexae, gallbladder and other organs may produce extrinsic defects in the barium filled colon.

Cases III and IV presented a diagnostic triad which can be exemplified as follows: (1) Acute left lower quadrant peritonitis resembling diverticulitis; (2) barium enema showing no diverticula but perhaps showing sigmoid spasm; (3) small bowel distention in the left abdomen resembling localized ileus such as is seen in the "sentinel loop" in acute pancreatitis. Diverticulitis was one of the two admitting diagnoses in Case III but this entity is relatively uncommon at the age of thirty. The roentgen changes on barium enema study were similar to those encountered by Le Vay[10] in his case. However, symptoms had been present only twenty-four hours in our case, while Le Vay's case gave a fifteen month history of left lower quadrant pain.

Cases V and VI simulated typical episodes of acute appendicitis while Case VII presented what was presumed to be a simple incarcerated inguinal hernia.

Our first 4 cases all complained of left lower quadrant pain and 3 of them showed roentgen changes confined to the sigmoid colon. This localization admittedly simplifies the diagnostic possibilities. An acute attack of right lower quadrant pain in a patient who has not had the appendix removed is only on occasions evaluated by barium enema studies. In the absence of a small tender movable mass or other suggestive clinical information, the diagnosis of disease of the appendices epiploicae would rarely be considered. However, it is believed that entertaining the diagnostic possibility more generally may result in the proper diagnosis.

The roentgen appearance one might anticipate encountering in disease of the appendices epiploicae apparently follows no definite pattern and would depend upon the chance position of the offending appendix, its length and the acuteness and severity of the underlying pathologic process. It would appear that it should produce evidence of extrinsic disease, either inflammatory, mechanical or tumefactive in origin, yet it could mimic intrinsic malignant disease. The similarity to a volvulus is evident in retrospect on the postevacuation study in Figure 2*B*, in contrast to the preoperative diagnosis of carcinoma.

SUMMARY

1. Seven surgically proved cases of gangrene, torsion or inflammation of an appendix epiploica are described, together with the roentgen findings in 4 of the cases.

2. Barium enema studies in 3 patients revealed different findings in each case. Case I simulated an encircling carcinoma. Case II revealed evidence of an extrinsic mass and Case III showed spasm and edema of the mucosal folds. A scout roentgenogram in a fourth case disclosed reflex ileus.

3. The clinical diagnosis is usually elusive in patients with inflammatory conditions of the appendices epiploicae. With the assistance of adequate clinical information, the diagnosis of torsion, thrombosis, gangrene or inflammation of an appendix epiploica may be suggested in the presence of certain changes on a barium enema study or a scout roentgenogram, if not as a primary diagnosis, then at least as a diagnostic possibility.

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ADDENDUM

Since preparation of this manuscript, two articles (Lynn, T. E., Dockerty, M. B., and Waugh, J. M. A clinicopathologic study of the epiploic appendages. *Surg., Gynec. & Obst.*, 1956, *103*, 423–433; and Astler, V. B., Carver, G. B., and Carmona, M. G. Epiploic appendages as a cause of intestinal obstruction. *A.M.A. Arch. Surg.*, 1958, *76*, 555–558) on diseases of the appendices epiploicae have appeared in the surgical literature, with roentgenograms illustrating 2 cases simulating carcinoma of the colon, while a third case illustrated an extrinsic defect of the colon.

The authors acknowledge the kind permission of Dr. Leon Manheimer to report the surgical findings in Case II and of Dr. Stanley Frehling to report the surgical findings in Cases

v and vi. Dr. Jack Widrich graciously allowed the use of roentgenograms in Case i and Dr. Richard D. Shapiro did likewise in Case iii. The Hafner Publishing Company of New York was kind enough to permit the reproduction of Figure 1 from Sobotta's Atlas of Descriptive Human Anatomy.

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CLINICAL AND ROENTGENOLOGIC CORRELATION OF PHYSIOLOGY OF THE COLON*

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A KNOWLEDGE of the physiology of the colon finds its most common clinical application in the daily practice of the radiologist. Some of the principles involved are in routine, if unconscious, use in examining the colon by barium enema. A better understanding of the function of the colon will increase the safety and efficiency of the procedure and provide a basis for interpreting certain of the less usual appearances that are encountered.

PHYSIOLOGY

Peristalsis. Peristalsis of the large bowel has been studied by Templeton and Lawson,[24] and the wave patterns seen in motility records of the colon have been classified. This classification has been adapted to human beings.[1] Included are four types of wave patterns[16,23] but Types I and III are of low amplitude and are never recognizable by the radioscopist.

Type I waves produce about 5 to 17 cm. of water pressure and are of five to twenty seconds duration[4] but are nonpropulsive.[1,16,23] Type III waves are formed by changes in base pressure and are apparently tonus waves; these are infrequent and of low pressure which is about equal to that found in Type I waves.

Type II waves, lasting twelve to sixty seconds and creating pressures of 10 to 50 cm. of water,[9] are seen as localized segmental contractions sometimes limited to individual haustra, and some investigators feel that these waves cause constrictions in the colon that result in the haustral pattern (Fig. 1). Their function is believed to be principally a churning and mixing movement which contributes to dehydration of the intestinal contents.[1,6,9,16,23] Some hold that these waves may be coordinated[4] to cause propulsion from one colonic segment into the next distal segment.

Type IV peristalses are strong, usually arise just distal to the ileocecal valve or at the hepatic flexure and progress for varying distances usually stopping in the vicinity of the splenic flexure or proximal descending colon but sometimes continuing

FIG. 1. Type II peristalsis is demonstrated by the haustrations and by the localized contraction in the sigmoid flexure.

along the entire length of the colon. This is known as mass peristalsis (Fig. 2). Pressures created by mass peristalsis in the colon have been measured by many methods[3,22] and are reported as from 15 cm. of water to over 260 cm. of water pressure.

It has been said that no peristalsis and little or no movement occurs in the cecum and that the cecum empties by overflowing,[7] but peristalsis is observed to occur here not infrequently and occasionally may continue distally along the colon. Reverse peristalsis is uncommonly seen forcing contents from the cecum into the terminal ileum. Reverse peristalsis also has been said to occur in the descending colon[4] but has never been noted by the writer.

Relation of Small Bowel Motility to the

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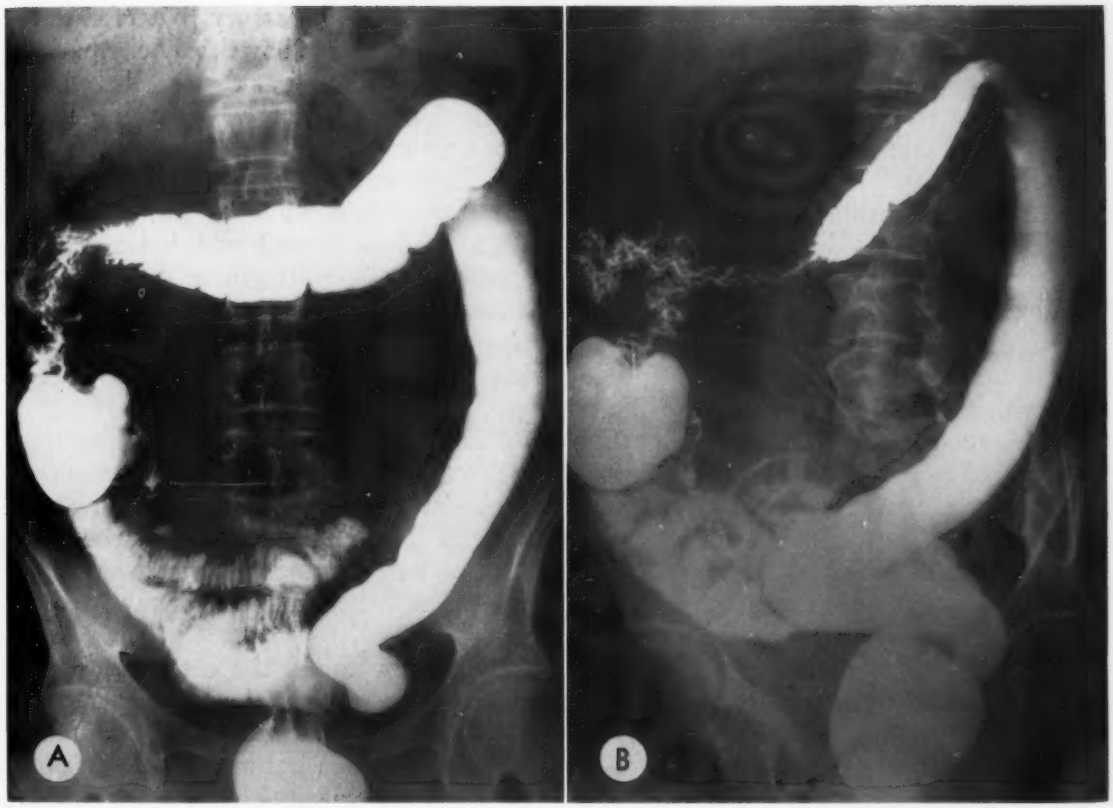

Fig. 2. (*A*) Type IV (mass) peristalsis in the proximal colon. (*B*) A second mass peristalsis in the same patient.

Colon. Small bowel motility time can be decreased, sometimes considerably, by a full colon due to physiologic obstruction, and this is seen in exaggerated form when fecal impaction of the colon occurs. Conversely, the small bowel motility may be increased by evacuation of the colon. This was observed in 2 patients having a small bowel study in which the barium had still not entered the cecum after five hours; evacuation of the colon following a tap water enema resulted in immediate and rapid progress of the barium into the colon.

In the small bowel, the peristaltic rush[3,7] is equivalent to the mass peristalsis of the large bowel. These can be stimulated by peristalsis beginning in the esophagus on swallowing and progressing through the stomach and into the duodenum. Food entering the duodenum reflexly stimulates small intestinal peristalsis. Fluid can move independent of peristaltic rushes through the small bowel and can also stimulate these rushes as it moves through the intestine.[3] These facts can be employed to advantage in the barium enema examination of the colon as will be discussed later.

Colon Capacity. The capacity of the adult colon was determined through fluoroscopy by Olsson[20] who found considerable variation, the average patient having a capacity between 0.6 to 3.0 liters. Constipated patients have a somewhat larger average capacity, the range being from 0.7 to 3.9 liters, while patients with diarrhea have an average capacity which is slightly reduced, the range being from 0.4 to 2.5 liters. Thus, the average capacity of the colon of the normal adult was found to be 1.45 liters, that of the constipated group 1.74 liters and that of the patients having diarrhea 1.38 liters. It was also noted by Olsson that normal adult males had a slightly larger average capacity than the normal adult female, but the difference was slight, 1.5 liters as compared to 1.4 liters.

Intracolonic Pressures. An investigation of intracolonic pressures during administration of an enema was conducted by the author to determine how often mass peristalsis occurs and to determine how often retrograde flow of fecal material into the enema container would occur. The water manometer was considered satisfactory for the purpose of measuring intraluminal pressures in this study, since, of all methods of measuring intraluminal pressures, this one most closely simulates the conditions which exist during administration of a barium enema. For the same reason, the routine used in preparation of the colon for a barium enema study was employed on a series of 19 patients: 2 ounces of castor oil and a tap water enema were administered the preceding evening; a tap water enema was then administered the next morning, and pressures were obtained by direct water manometer. Rapid sudden rises in rectal pressures above 50 cm. of water, interpreted as representing mass peristalsis, occurred in 14 of the 19 patients, the highest recorded pressure having been 138 cm. of water. Water pressure of about 75 cm. resulted in backflow of feces into the enema container which was suspended at a height of 2½ feet above the table, and this occurred in 12 of the 14 patients exhibiting mass peristalsis. Mass peristalsis was rarely exhibited until more than 1 liter of water had been administered suggesting that Type IV peristalsis is not stimulated until the water has extended to at least the splenic flexure or until there was considerable distention of the distal colon.

Similar findings were demonstrated by Lawson and Templeton[17] in dogs. Moderate distention of the proximal dog colon is followed temporarily by augmented tone and activity in the proximal colon, but similar distention of the distal colon does not alter activity of the colon significantly.

The average pressure required to rupture the outer two coats of the colon is about 3.5 pounds per square inch (approximately 234 cm. of water) while about 4 pounds of pressure per square inch (approximately 273 cm. of water) is necessary to perforate the mucosa of the large bowel.[8] By comparison, the pressure created at the rectal tip by an enema delivered from a height of 3 feet is about 90 cm. of water. A diseased bowel, such as that seen in carcinoma, diverticulitis, other inflammatory processes, and prolapse of the large bowel, however, may rupture with very little increase in pressure. It has also been shown that less intraluminal pressure was required to cause perforation if air was instilled rapidly into the rectum.

Water Absorption. Absorption of water is one of the most important functions of the large bowel. This occurs all along the large intestine, but the greater part of the liquid material entering the colon from the small bowel is absorbed in the cecum and ascending colon.

Innervation. As in the case of other abdominal viscera, the colon is innervated by both the sympathetic (inhibitory) and parasympathetic (motor) fibers. Those that innervate the proximal half of the colon are from the superior mesenteric plexus, while those innervating the distal half arise in the upper lumbar roots (sympathetic, which travel via the intramesenteric and inferior mesenteric plexuses) and from the second, third, and fourth sacral nerves (parasympathetic, which travel via the hypogastric nerve).[14] Pain fibers are found frequently in the sympathetic fibers and sometimes in the parasympathetic fibers. Sensation from the abdomen travels by these *visceral* pathways but also may sometimes travel through the *parietal* pathways which arise from somatic nerves and innervate the parietal peritoneum. Portions of the mesentery are also innervated to some extent by parietal pain fibers.[11] Thus, pain from the viscera frequently will be localized in two portions of the body surface because of these dual pathways, the parietal giving relatively sharp localization near the involved organ, while sensations passing over the visceral pathways give a more general localization often referred to areas removed from the involved organ. An example is

seen in the case of para-umbilical pain arising from appendicitis.

The normal individual is unconscious of most of the peristaltic activity which is present in the colon. Mass peristalsis (Type IV contractions) is, however, almost always recognizable as an urge to stool, and when this urge is not accommodated, the mass peristalsis will sometimes repeat itself and may give discomfort if defecation is resisted by the individual who usually describes the sensation as "cramps."

Pain is an unpleasant sensation which may cause a spectrum ranging from mild discomfort to marked distress when severe. Cramps are a form of pain which occurs in the colon, particularly when there is increase in peristalsis as found in inflammatory conditions and in obstruction. Not only is pain sensation arising from the colon more vague than that from the superficial body structures, such as skin and muscle, but it is also referred and, therefore, often not localized over the involved organ; it may be expressed as nausea. There is a lack of sensation to heat and cold, to handling, and even to cutting and cautery of the bowel, but pain may be initiated by traction on the mesentery, congestion, muscular contractions in the presence of ischemia, distention, especially when sudden, and by irritation by chemical agents produced by inflammatory processes.[14] Response to stimuli changes sharply when the pectineal line is reached where trauma, heat, and cold are easily and immediately recognizable, and pain is sharply localized.

White, Cobb, and Jones[27] showed the frequent occurrence of mucous colitis as a response to threatening situations in life, particularly in the easily offended, immature individuals. After clinical studies with parasympathomimetic drugs, they have concluded that these functional disturbances in the colon were probably the result of excessive parasympathetic stimulation. By mechanically producing headaches, Almy and Tulin[2] were able to generate stress resulting in emotional tension and physical changes, including hypertension, sweating, and skin pallor, while in the lower sigmoid increased peristalsis, secretions, and engorgement of mucosa were observed at proctoscopy.

Drug Effects. Code, Hightower, and Morlock[9] have given an excellent review of drug effects on the intestinal tract, and more detailed information may be found in the textbook by Goodman and Gilman.[10] It will suffice here to summarize very briefly the effects of those drugs with which the radiologist may most frequently be concerned.

Parasympathomimetic drugs, including methacholine, carbachol, physostigmine, neostigmine, and other drugs, stimulate motor activity of the bowel with increase in the number of mass peristalses.[2,6,19,20,23]

Atropine sulfate, although not necessarily the most effective drug exhibiting cholinergic inhibition, is nevertheless effective and probably the most widely used of this group for the production of motor activity inhibition in the colon. Syntropan and trasentine are members of this same group but are found to be ineffective as motor inhibitors in the large bowel.

Morphine sulfate is constipating by virtue of increased nonpropulsive motility and very definite decrease in propulsive motor activity of the colon; the tone of the large bowel is increased.[22] Codeine has a similar but much less marked effect. Demerol, on the other hand, has little or no effect on the colon. Phenobarbital is also ineffectual on the colon motility.[25]

Castor oil is a triglyceride of ricinoleic acid, a fatty substance, which is hydrolyzed by the fat splitting enzymes to glycerol and ricinoleic acid, the latter being the active agent in production of catharsis. A marked irritant, ricinoleic acid stimulates the motor activity of the small intestine leading to a rapid propulsion of contents through the small bowel and the colon. There is little effect on the colon since the ricinoleic acid is absorbed in large part in its passage through the small intestine. Doses larger than 15 to 30 cc. do not increase the effect since sufficient ricinoleic acid is released by

hydrolysis of the ingested oil, resulting in catharsis with the remainder of the acid removed from the intestine while still combined with glycerine.[25]

CORRELATION WITH COLON ROENTGENOLOGY

The purpose of correlating colon roentgenology and physiology is to provide a more satisfactory examination, to decrease the discomfort to the patient as much as possible, to prevent any undesirable complications, and to take advantage of physiologic phenomena, such as observed at the gastro-ileal and gastrocolic flexures.

Preparation of the Patient. The most important portion of the roentgenologic examination of the colon is the proper preparation of the patient. Castor oil has long been acknowledged the most effective substance for cleansing the colon. To obtain the best results, it should be administered only after the upper gastrointestinal tract has emptied itself of all solid materials into the colon, and no additional food substances that might form solid fecal material should be added afterwards. The dose of castor oil should not exceed 30 cc., since it is desirable to leave as little oil in the colon as possible. Because it is extremely difficult to cleanse the bowel completely of all fecal material, cleansing enemas should be given later to complete the purgation; this is also of help in ridding the colon of any oil droplets which may be confused with polyps. If, for some reason, enemas cannot be given, then phospho-soda may be administered instead. With these facts in mind, the following regimen for preparation of the patient is suggested: (1) Clear liquid diet for thirty-six hours prior to the examination, beginning with supper; (2) thirty cubic centimeters of castor oil at bedtime on the night of the first liquid supper; (3) one and one-half quarts of tap water as an enema at about 4:00 P.M. on the day preceding the examination. Forty-five cubic centimeters of oral phospho-soda may be substituted for this enema; (4) repeat enema at bedtime.

Circumstances may require a variation in this technique. In order for the enemas to be effective, it is important that the patient be instructed to retain all of the enema until it has all run into the colon before evacuating it.

Administration of the Barium Enema. Rapid filling and distention of the rectum and rectosigmoid regions need not be avoided since this seems to have little effect on other portions of the colon, but beyond the rectosigmoid junction, care should be taken to fill the colon relatively slowly without localized areas of distention. The height of the enema container may be adjusted, and pressures in the rectum generated by a barium enema column of 3 or $3\frac{1}{2}$ feet is of no danger, the pressure ranging from approximately 90 to 110 cm. of water pressure, which is similar to that generated by mass peristalsis. Since it is advantageous to follow the head of the column of barium as it progresses proximally, the flow of barium should be interrupted intermittently in order to go back and visualize in different positions that portion of the colon already filled. The well cleansed colon is seen to fill very easily and rapidly and usually with less discomfort to the patient; the castor oil and the enemas do not appear to have influenced the peristalsis in the colon significantly.

Although the colon itself is insensitive to heat and cold, an enema which is considerably warmer or colder than body temperature may prove uncomfortable for the patient because the region below the pectineal line and about the anus is sensitive to temperature change. No significant effect on peristalsis by moderate variations from body temperature was noted, but it was not known what effect great variations in temperature might have.

Sites of delay in filling the colon may be met occasionally at the sigmoid and splenic flexures, and these may be due to folding or turning of the bowel or to an exaggerated Type II contraction (Fig. 3). Efforts to overcome these may be made by rotating the patient into different positions and by continuing the pressure of the enema. Some-

times they are found to be almost impossible to overcome, and in such instances 0.85 mg. of atropine sulfate may be given intramuscularly and the examination repeated approximately one hour later. This has been seen to happen, particularly in the sigmoid flexure in the presence of diverticulitis.

Discomfort of the Patient. The most marked discomfort that the patient experiences during the examination occurs with the appearance of the mass peristalsis (Type IV contractions). These usually do not occur until the barium enema has reached the mid-descending colon or above. Although this type of peristalsis can occur in a colon which is not distended, it is more frequently found with distention of the colon and with prolongation of the time of administration of the enema. This was demonstrated by the author when he was able to stimulate mass peristalsis in 13 out of 19 cases as compared to 20 in more than 1,000 barium examinations of the colon reported by Holzknecht.[13]

When mass peristalsis occurs, there may be reflux of some of the colon contents into the enema container. In most private offices and hospital radiologic departments, only the rectal tip is changed between patients and more barium is added to the enema container for the next patient. It can readily be seen that, although this is fast and convenient, the aesthetic point of view, if not the possibility of a health hazard, is neglected.

The usual reaction of the roentgenoscopist to mass peristalsis is to close off the enema tube; however, allowing the tube to remain open and lowering the enema container will permit the patient to evacuate his bowel into the container. This results in less discomfort to the patient and less likelihood of accidental evacuation of the barium on the fluoroscopy table. Another advantage of this procedure is that the colon is allowed to empty itself of fecal material and any castor oil which may be present. These substances will float in the barium mixture and remain in the enema container while the colon is being refilled, thus providing a more thoroughly cleansed colon.

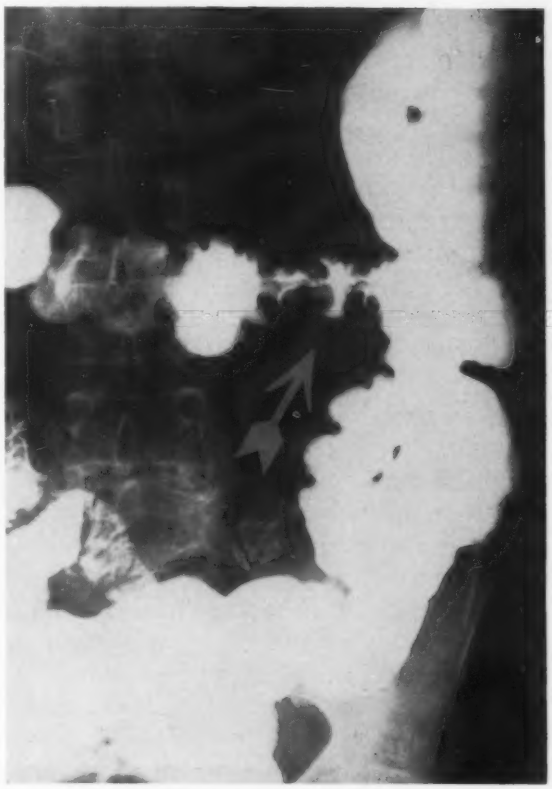

Fig. 3. Area of spasm at distal end of the transverse colon. This is a form of Type II peristalsis.

The fearful patient has apparent increase in cramps during the administration of the barium enema and is often unable to cooperate to the conclusion of the colon examination. This patient may be aided by a friendly attitude on the part of the examiner, by a simple explanation of the examination, and by his reassurance.

The main cause of the greater discomfort engendered by air contrast studies as compared to barium enemas is largely the rapid overdistention of the colon with air. It is easier to avoid this discomfort by introducing the proper amount of air slowly without overdistention than by treating the patient's cramps. If overdistention does occur however, this may be relieved by inserting a soft rubber catheter and having the patient turn in various positions with bearing down. It has been shown recently that the use of carbon dioxide in place of air in

double contrast examinations has resulted in complete absence of discomfort which is usually present when air is used.[18]

Management of the Barium Filled Ileum. Reflux of barium into the ileum during the barium enema study may obscure the sigmoid flexure which might then require re-examination, particularly if pathology is questioned here or if visualization has been incomplete. If this is to be re-examined immediately, it would be necessary to empty the barium from the ileum first. A physiologic factor which may be put to work for this purpose is the peristaltic rush in the small bowel, equivalent to the mass peristalsis in the colon. The stimulation of the peristaltic rush[3,7] can be brought about through use of the gastro-ileal reflex by having the patient eat some food, but more effectively by having the patient drink a large quantity of water, approximately 20 to 24 ounces, as quickly as possible and then repeating in about fifteen or twenty minutes. Fluoroscopy and roentgenography thirty minutes later have shown this to be very effective for emptying the ileum in approximately 65 per cent and partially successful in about 20 per cent of patients (Fig. 4 and 5). An additional important factor involved in the above mentioned method of clearing the ileum is the rapid passage through the small bowel, independent of peristalsis, of the ingested water which dilutes the barium mixture and displaces it into the cecum. This mechanism is similar to that used in flushing out a tube or pipe.

In this connection, the factors of peristalsis and flushing the small bowel can also be used to help complete the small bowel study in those cases where passage of the barium through the ileum is prolonged, or where it is desired to speed the examination after the barium has reached the ileum. Examples of the utility of this information

Fig. 4. (*A*) Reflux of barium into the small bowel during a barium enema examination as shown on the post-evacuation roentgenogram. (*B*) Same patient thirty minutes after ingestion of 24 ounces of cold water showing complete displacement of the barium from the small bowel into the colon. This demonstrates the gastro-enteric reflex and flushing mechanism.

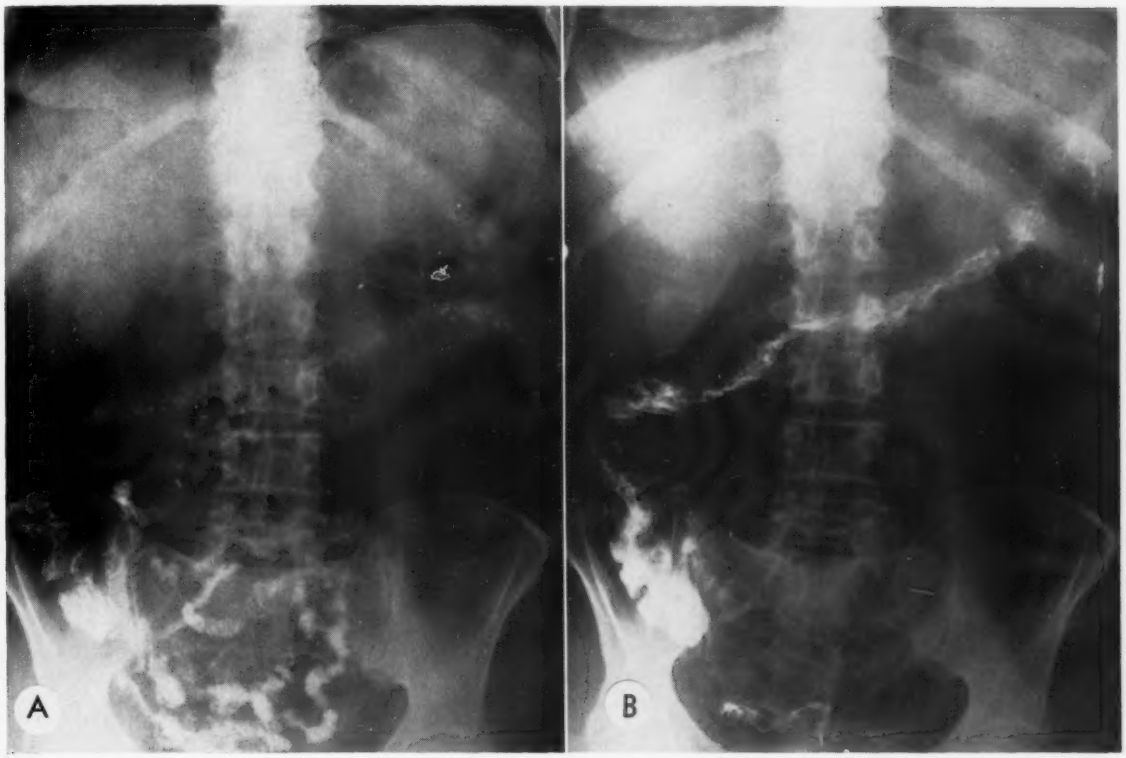

Fig. 5. (*A*) Postevacuation roentgenogram showing reflux of barium into the small intestine. (*B*) Same patient thirty minutes after ingestion of 24 ounces of cold water. Employment of the gastro-enteric reflex and flushing mechanism has resulted in almost complete evacuation of the barium from the small bowel into the colon.

were found in several patients in whom the ingested barium entered the ileum within one to two hours and then refused to move further into the terminal ileum and colon within another period of one to two hours. Within thirty to sixty minutes after ingestion of a large quantity of cold water, however, the barium was seen to have emptied into the colon (Fig. 6 and 7).

Hazards of the Roentgenologic Examination. The frequency of perforation in examination of the large bowel is probably greater than the few reported cases indicate.[21,25,26,28] The improper use of enema tips and balloons are the commonest causes of perforation. The injury is usually observed on the anterior wall of the rectum just above the pectinate line where the sensory nerve supply is greatly diminished so that perforation may result without the knowledge of the patient and even the radiologist. Such traumatic perforation is more apt to occur in the presence of disease. Where it is necessary to inflate the balloon of a Bardex bulb more than usual to prevent expulsion of the barium enema, it might be wise to measure the pressures being applied through the balloon by means of a mercury manometer. This pressure should be less than that necessary to rupture the colon. Burt[8] found that approximately 3.5 pounds per square inch (18 cm. of mercury) is the average pressure required to rupture the outer two coats of the colon, and approximately 4 pounds per square inch (21 cm. of mercury) is the amount necessary to perforate the mucosa of the large bowel.

In the absence of trauma, the diseases most likely to lead to perforation include carcinoma of the colon, diverticulitis, congenital anomalies of the colonic wall, ulcerative colitis, lymphopathia venereum, chronic herniation of colostomy, and other less

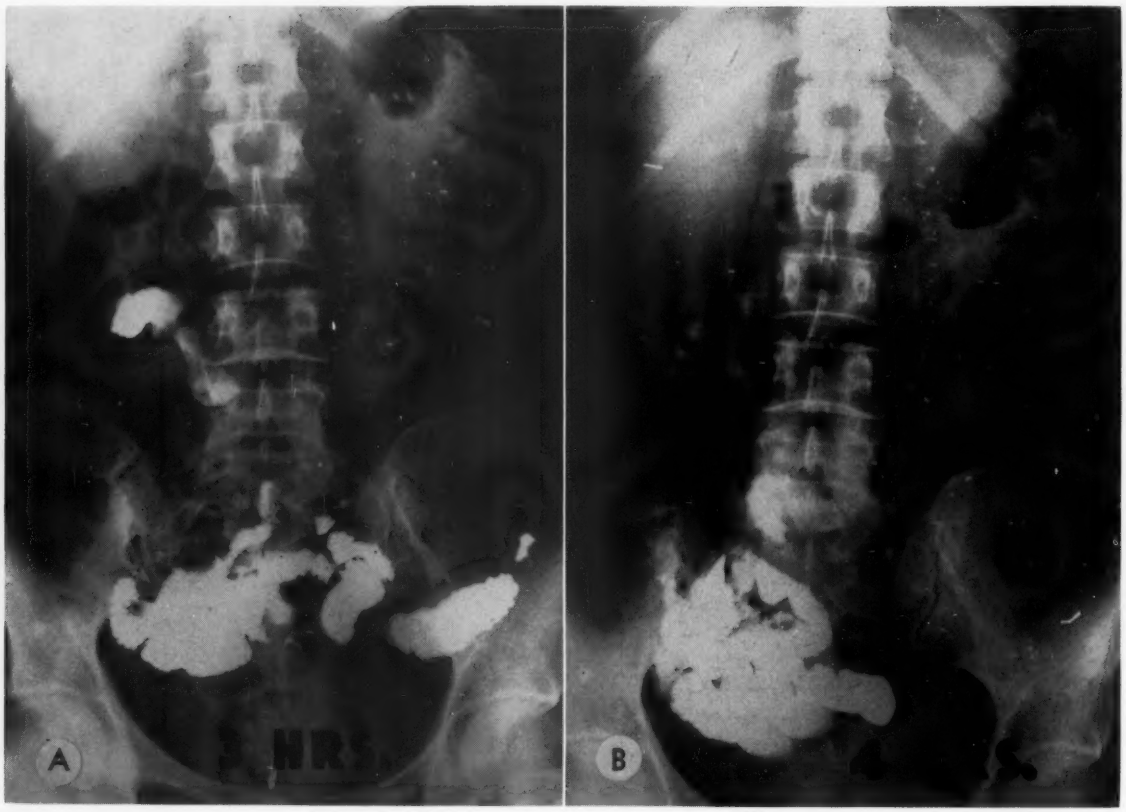

Fig. 6. A barium column is moving very slowly through the small intestine as demonstrated by its position in the small intestine at three hours (*A*) and four hours (*B*).

common lesions[28] listed in order of frequency. Overdistention of the colon by fluid or air is a factor in these accidents[5] although usually of secondary importance as suggested by the work of Burt.[8] Nevertheless, great precaution to avoid overdistention should be taken, particularly in the presence of pathologic involvement of the colon.

Although widely recognized by radiologists, another hazard that should be mentioned in connection with roentgenologic examination of the colon is water intoxication. This hazard is greatest in cases of Hirschsprung's disease but may be observed in other patients as exemplified by the reported case of a fifty year old woman who expired after she received 9,000 cc. of water in thirty hours by proctoclysis.[12] Postmortem examination showed edema of the brain, and there was perivascular edema; no lung or heart pathology was found. Death due to water intoxication in Hirschsprung's disease following a barium enema examination was reported by Jolleys.[15] To avoid water intoxication in Hirschsprung's disease and in patients receiving multiple enemas within a short period of time, normal saline should be used in place of tap water. When barium enema studies are performed to diagnose Hirschsprung's disease, the enema should be limited to that amount necessary to demonstrate the pathology; thus, it may be necessary to fill only the rectum and sigmoid portion of the colon. Solutions of powdered hypaque in normal saline, still in the experimental stage, should prove easier to evacuate and will eliminate the danger of impaction inherent in the barium sulfate suspension.

Relation of Peristalsis and Disease. Increase in Type II peristaltic waves results in increased contractility of localized segments of the colon and may cause spasm.

Fig. 7. Same patient as in Figure 6. Thirty minutes later, after ingestion of 24 ounces of cold water by mouth, the barium column has moved quickly into the terminal ileum and cecum—another example of the usefulness of the gastro-enteric reflex and flushing mechanism.

This indicates the presence of an inflammatory process and is most commonly associated with diverticulitis. In the cecum, one would suspect appendicitis, diverticulitis, amebiasis, tuberculosis, or other inflammatory disease.

There are some individuals whose colons respond with marked increase in Type IV peristaltic waves but this is also one of the earliest signs of ulcerative colitis so that this disease entity must be suspected in the presence of increased mass peristalsis.[16,23] Later in ulcerative colitis, Type II peristalsis decreases and then disappears and, with it, the haustral contractions which are apparently a result of the Type II contractions.[2,23] The mass peristalsis decreases only later when the walls of the colon have become rigid.

CONCLUSION

Physiology of the colon as related to the roentgenologic examination of this organ has been reviewed. The clinical implication of some of the principles involved has been suggested for use in the daily practice of the radiologist.

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THE VALUE OF MULTIPLE BARIUM ENEMA STUDIES*

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THE excellent critical analysis of current methods of examination of the colon by Robinson[19] makes further recorded review unnecessary at this time. The inevitable conclusion to be drawn from his observations as well as those of others, and borne out by personal experience, is that on the whole practicing radiologists are not accomplishing the primary purpose of their examinations often enough; namely, that of disclosing the precancerous or small carcinomatous polyps in the colon, particularly beyond the area of visual sigmoidoscopy.[27,32,33,34] The incidence of surgical cures could be raised from the present 10 to 20 per cent variable to a potential 90 per cent, were the incidence of detection of polyps likewise raised to achieve this potential.[2,6,10,21,29] The need for confirmation of a positive finding has been emphasized in many publications.[1,3,8,9,13,14,16,28,30]

The method described in this paper differs from others only in that the colon is routinely filled with barium twice in immediate succession during the first day of examination.

In a series of 393 hospital examinations, only 29 per cent were considered satisfactory after one barium enema; 63 per cent were satisfactory after two barium enemas. Of 137 office examinations, 24 per cent were satisfactory after one barium enema and 78 per cent after two barium enemas (Fig. 1, *A* and *B*, and Fig. 2, *A* and *B*). These figures prove the value of immediate successive barium enema examinations. They also point to the better preparation of the office patients as compared to the hospitalized patients.

It is the author's opinion that no available procedure can equal the efficacy of the two-enema technique in which the second barium enema is given immediately after examination by the first barium enema and its evacuation. Emphatically, achievement of success lies in the immediate succession of these barium enema studies, apart from any subsequent re-examinations which may be required.

PRINCIPLES OF TECHNIQUE FOR OUTLINING LESIONS IN THE COLON

These are as follows:

1. The lesion cannot be pinpointed and outlined unless the colon has been completely cleansed.

2. Adherence of the barium to a lesion advantageously delineates the lesion.

3. In order to recognize small lesions of the colon, every barium enema must produce a contrast between either barium and the polyp or the polyp and air. If the barium suspension is too thin,[19] contrast will be lacking between the watery solution and the polyp (Fig. 3). On the other hand, the consistency of the barium must not be so thick[8] as to obscure a lesion (Fig. 4, *A* and *B*).

4. Because of the second peristaltic wave induced when tannic acid is the cleansing agent, only a moderate amount of barium is left in the colon at the time air insufflation is undertaken. Too much retained barium limits the value of the air contrast examination.

5. The diseased area must be outlined by fluoroscopy, using oblique and compression views, and, also, special views when necessary.

6. The technical factors in taking roentgenograms should be satisfactory to obtain contrast[5,6] by a Bucky diaphragm or grid.[17] A Bucky diaphragm or grid on the fluorosopic screen is almost indispensable. Insufficient contrast on spot roentgenograms of large or obese patients can result in failure of visualization.

7. A routine barium enema examination

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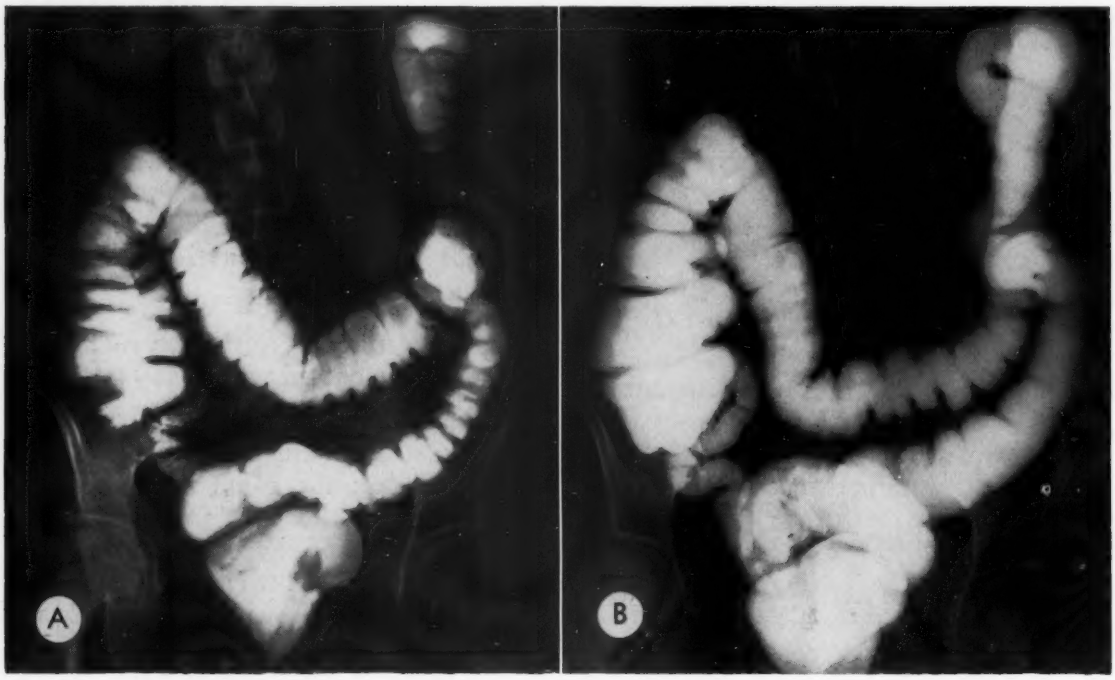

Fig. 1. (*A*) Roentgenogram after first barium enema. Note inadequate preparation. (*B*) Roentgenogram after second barium enema, given immediately after evacuation of the first enema. Note cleansing effect.

requires a high enough kilovoltage to penetrate[8,18] through the patient and his barium-filled colon. Failure to penetrate the barium column in the colon means that an examination by a barium enema has, in fact, not been made (Fig. 4*A*).

8. Mucosal studies[3,4,11] frequently disclose a polyp that was not recognized during routine fluoroscopy or within an underpenetrated barium column (Fig. 5, *A* and *B*). On the other hand, the conclusion is not justified that good mucosal appearance precludes the possibility of the presence of a small lesion of 1 cm. or less. Small polyps have been demonstrated repeatedly during full-colon or air contrast examinations, not-

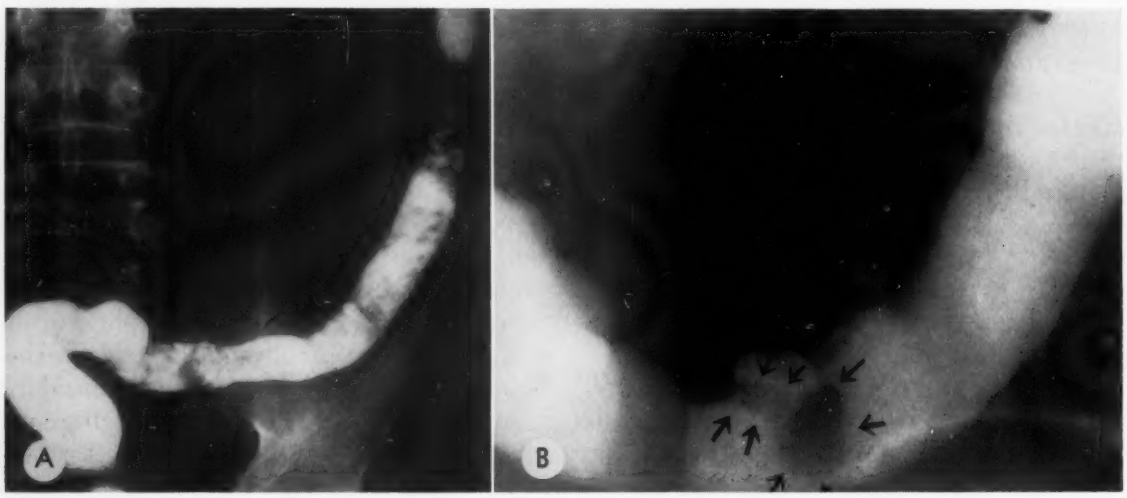

Fig. 2. (*A*) Sigmoid and descending colon as seen after first barium enema administration. Polyp not detected at this examination. (*B*) Note cleansing effect. Polyp including stalk discernible in sigmoid (arrows) after second barium enema administration a few minutes later.

withstanding the negative results of mucosal studies of the bowel.

9. Air insufflation[22–25] offers contrast opportunity when the polyp is coated or even, on occasion, when there is no barium coating. This is accomplished similarly to the manner by which lesions are recognized with the aid of encephalography or ventriculography.[19] One may lose sight of a lesion even when the colon appears to have been satisfactorily air-filled.

10. Whenever feasible and advisable, reexamination for the purpose of air injection is done on the following day. The dosage of castor oil is repeated in preparing the patient.

TECHNIQUE

CLEANSING OF THE COLON

The cleansing of the colon in the case of ambulatory patients is accomplished at home. Ambulation seems to influence favorably the result obtained. Outpatients and office patients have more thoroughly cleansed colons than hospital patients when they present themselves for examination.

The following procedure is recommended:

(a) A nonresidue liquid dietary regimen for twenty-four to seventy-two hours before examination is a major requisite. During that period the patient abstains from eating fats, fried foods, and dairy products. Jello, broth and dry toast are permitted.

(b) The administration of castor oil, in doses of 2 ounces, is a significant step in the cleansing procedure. As a rule, the patient takes the prescribed castor oil in orange juice. The 2 ounce dosage[16,23] has never been troublesome in my experience. The examiner should not be influenced by the social level of the patient in prescribing castor oil.[16] Other cleansing agents, such as neoloid and milk of magnesia, have not proved efficacious.

(c) The patient is instructed to take repeat water enemas at home until the return is clear, up to three hours before the barium enema study is undertaken.

(d) Despite all efforts to cleanse the colon, fecal matter often remains at the time of examination. For this reason, the first filling of the colon with barium should be regarded as a scout examination as well as a step in further cleansing the bowel. The second filling of the colon with barium is intended for the conclusive examination.

Fig. 3. Polyp in the distal descending colon (arrows) not recognized with certainty in spot roentgenograms shown in the insert at the left lower corner. Double contrast examination failed to produce visualization of the polyp due to the fact that the barium suspension was too thin. There was a lack of contrast in the spot roentgenograms despite the oscillating grid in the fluoroscope.

(e) It is not always easy to judge whether the bowel has been adequately cleansed, in readying the patient for an air injection. Mucosal folds may indicate excellent cleansing; yet, on insufflation of air, fecal matter may be disclosed in the colon. Apparently, although small pieces of fecal matter are present in the bowel, they may not be recognized, as a small polyp may not be recognized despite an excellent mucosal pattern.

CHOICE OF BARIUM

The problem of choosing the barium

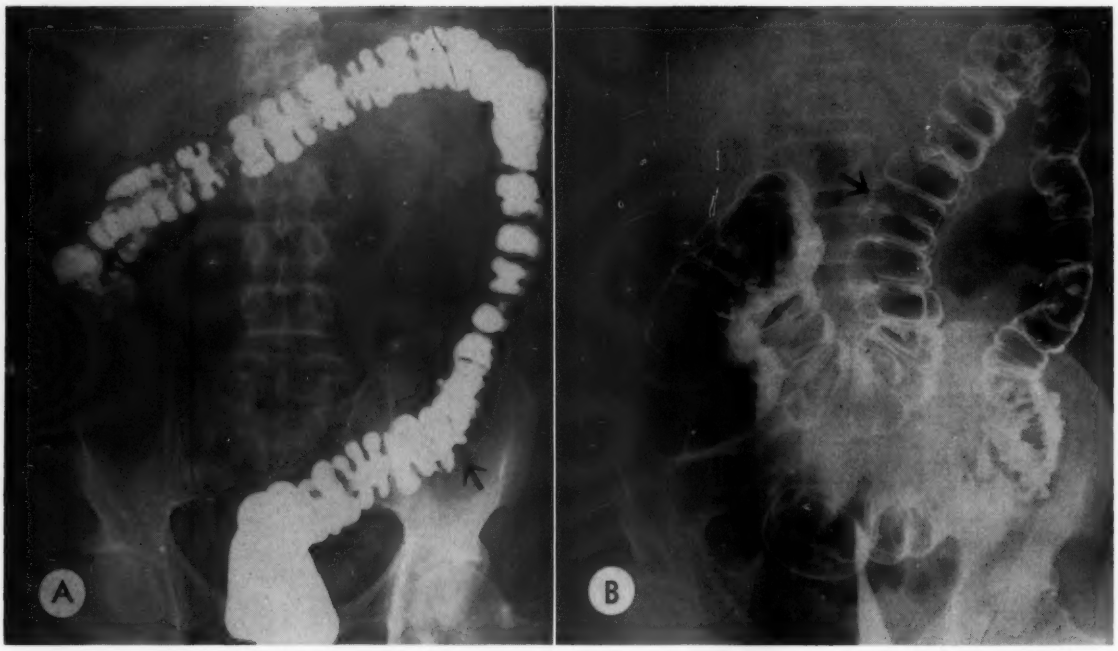

Fig. 4. (*A*) Pre-evacuation roentgenogram taken on the second day of examination before air insufflation. The lesion at the junction of the sigmoid and descending colon was seen for the third time as a negative shadow (arrow) following the administration of heavy barotrast to coat the polyp. The lesion was inadequately demonstrated on five air contrast roentgenograms. (*B*) On the other hand, the small lesion in the distal transverse colon (arrow) was better, more convincingly demonstrated on the air contrast roentgenograms.

which would best adhere to the bowel wall and polyp has by no means been solved (Fig. 6, *A* and *B*). The writer's experience with micronized barium or colloidal barium has not been extensive; however, a trial of each type was disappointing. One requirement is that the barium not only advance into the colon readily but that it also be evacuated without too much retention. To accomplish this dual purpose, veri-o-pake to which tannic acid[11] has been added is quite acceptable. Barotrast[7] seems to coat the lumen better, but tannic acid cannot be combined with it satisfactorily. It is possible to visualize a polyp in the bowel even when it is not coated with barium, in the manner in which a lesion is recognized in an air-filled ventricle by virtue of its own density.

Winthrop's experimental bowel irritant, WIN 9059A, in doses of about 10 mg., seems to be an adequate irritant and can be combined with barotrast. The cleansing results appeared to be somewhat better than when tannic acid was the agent, but the mucosal appearance was not as satisfactory. WIN 9059A may also be utilized to cleanse the colon when its contents interfere with visualization of the gallbladder.

U.S.P. barium in weighed amounts (6 ounces by weight) is satisfactory for routine barium enemas when combined with tannic acid in weighed amounts (5 gm. to 10 gm.). If an air insufflation is planned, or if there is a likelihood that it will be made on the same day, veri-o-pake with tannic acid, or barotrast with WIN 9059A is used instead of the U.S.P. barium combined with tannic acid. Tannic acid is incorporated in the barium mixture, not only because of its irritant property but also because of its mucosal effect. Barotrast and veri-o-pake columns do not break or dry out during the fifteen or twenty minutes required for evacuation. Tannic acid frequently causes a second wave of peristalsis; consequently, if the patient leaves the toilet too soon, he may not be able to remain on the table throughout the second examination.

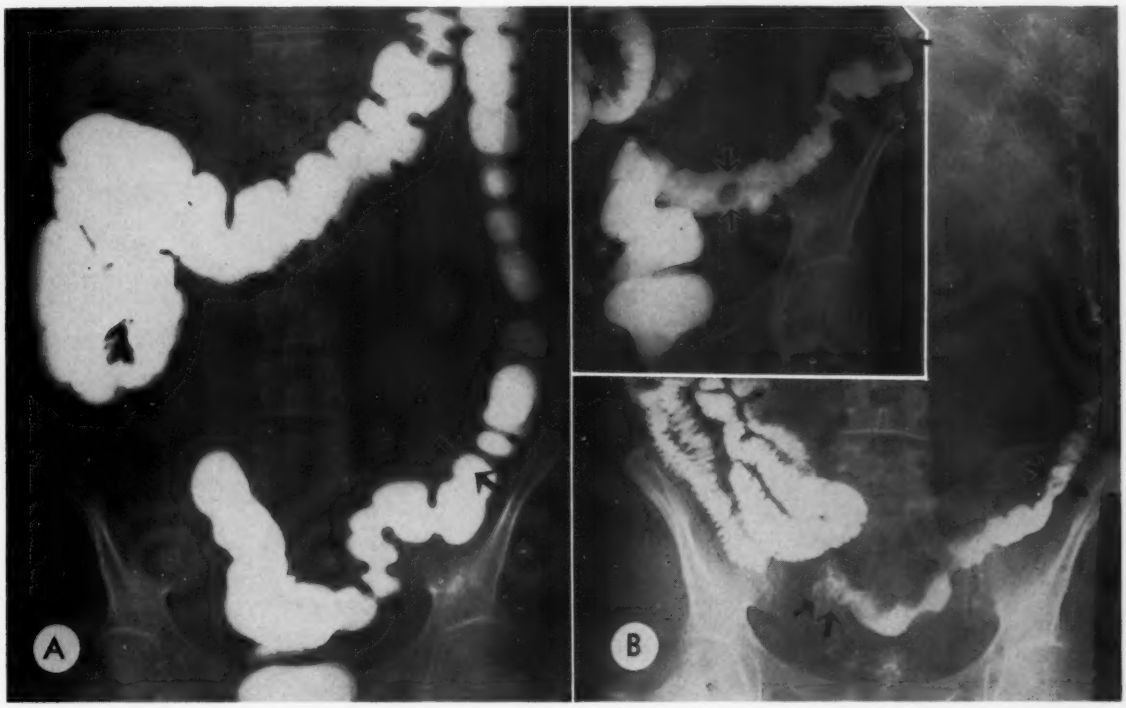

FIG. 5. (*A*) At the first examination there was an inadequate distribution of the barium, which was too thick. A lesion present in the midsigmoid (arrows) could only be seen at fluoroscopy and on spot roentgenograms. A second smaller lesion at the junction of the descending colon and sigmoid would have been overlooked had it not been noticed on the first set of roentgenograms and at the second examination on the same day (*B*). It is this constancy of the findings that is important for the recognition of small lesions of the colon. Note that the sigmoid polyp has moved several inches during the interval between the subsequent roentgenograms. This factor can be confusing.

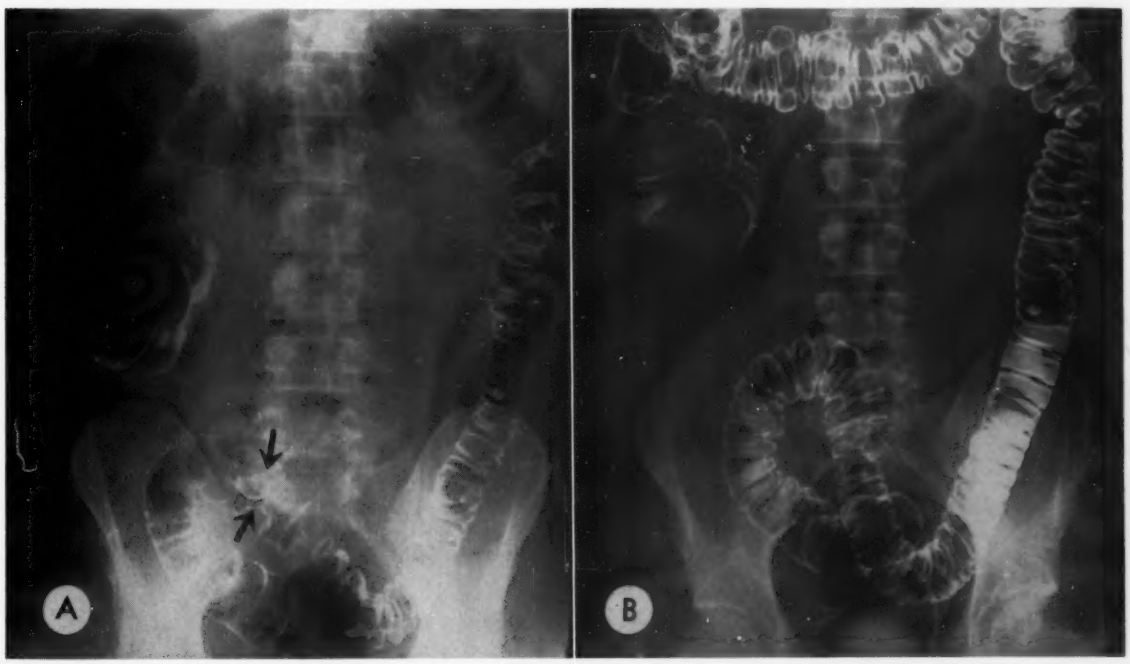

FIG. 6. (*A*) Polyp adequately demonstrated elsewhere (arrows). (*B*) Attempted confirmation by air contrast study remained unsuccessful despite knowledge that a polyp was present. Repeated cleansing enemas on the day of air insufflation hampered results. It is this element of uncertainty that makes multiple roentgenograms and manifold techniques necessary.

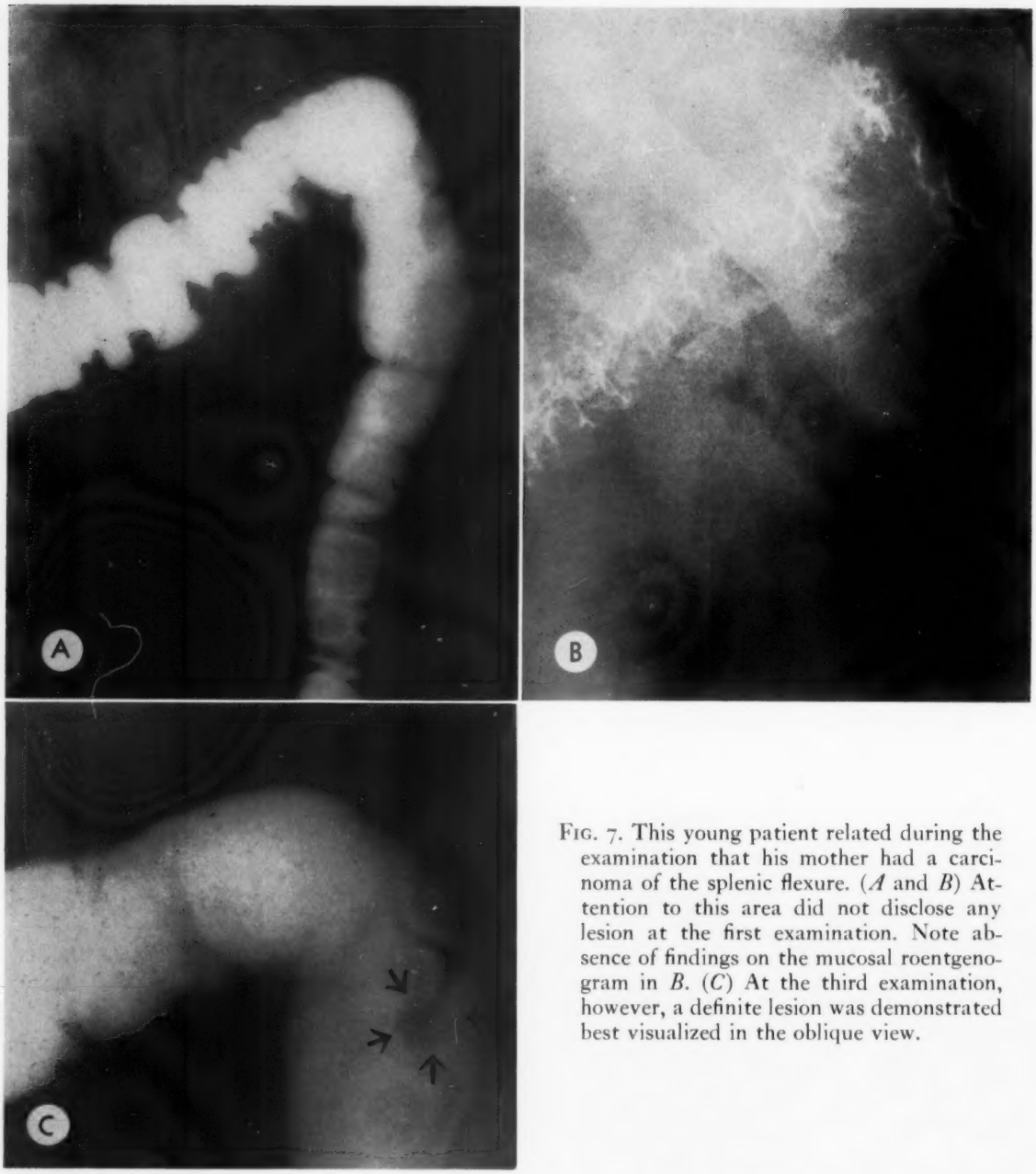

Fig. 7. This young patient related during the examination that his mother had a carcinoma of the splenic flexure. (*A* and *B*) Attention to this area did not disclose any lesion at the first examination. Note absence of findings on the mucosal roentgenogram in *B*. (*C*) At the third examination, however, a definite lesion was demonstrated best visualized in the oblique view.

FIRST EXAMINATION

Antecedent History. The antecedent history elicited from the patient as the clysma advances may be helpful.[20,31] In relating the account of an illness, the patient may indicate the site of a parent's or relative's lesion. Concentration on the comparable area may lead to disclosure of small lesions that otherwise might be overlooked (Fig. 7, *A*, *B* and *C*). Such small lesions may well represent the counterpart precursors of the malignancies from which relatives suffered. The familial tendency to malignancy in the colon has been observed by several authors, notably Rosi,[20] and is currently under investigation by Turell.

Slow Advance of the Barium Column. The flow of the barium enema must be controlled so that the column should advance slowly, thus preventing overdistention of

the bowel and difficulty in retaining the clysma. Small lesions in the colon and rectosigmoid can be visualized best when there is partial distention (Fig. 8). An overdistended barium-filled segment[30] of the colon, such as the cecum or rectum, is difficult to penetrate with a roentgen-ray beam. Moreover, overdistention may hide a polyp just as a greatly distended gallbladder may conceal a small stone; whereas, when the same gallbladder has contracted, minute stones may be outlined. The right half of the colon is two and a half times the size of the left half.[5] Compression of the barium-filled loop may be helpful; but, unfortunately, the compression cones available are often too short to reach the abdomen when the patient is in an oblique position under the fluoroscope.

Stopping Flow of Barium for Systematic Spot Roentgenography. The barium enema is never permitted to flow while spot roentgenograms are being taken, because a polyp moving in the enema stream may thus escape detection. A polyp can move several inches during the interval between two

Fig. 8. Small sigmoid lesions are diagnosed when the findings are constant (arrows). Overdistention of the sigmoid makes recognition of smaller lesions difficult. Slow advance of barium prevents overdistention.

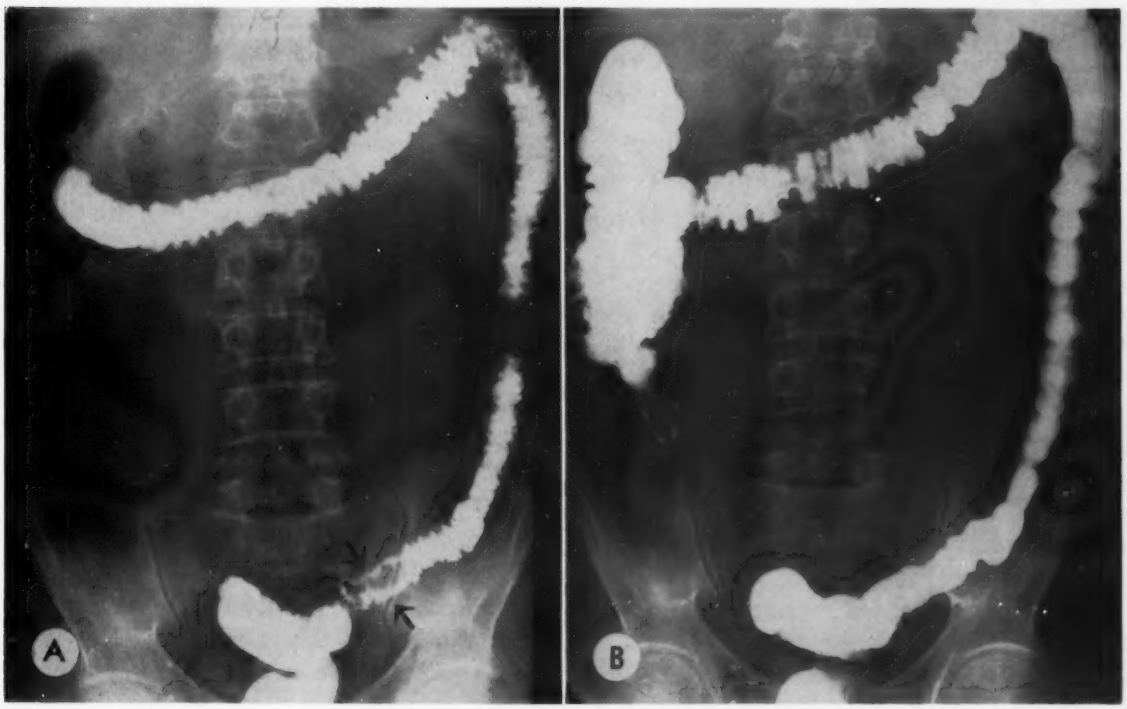

Fig. 9. (*A* and *B*) Difficulty encountered when the polyp changes its position during the examination.

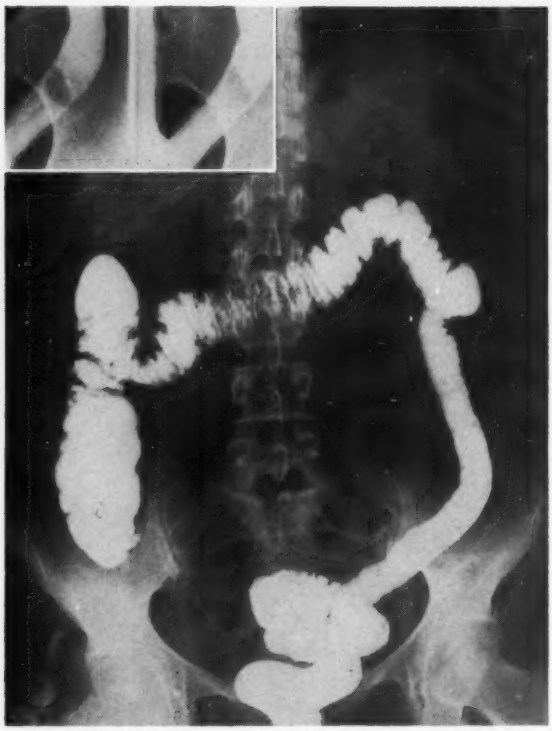

Fig. 10. In this case the polyp had a long pedicle, and as the barium column advanced it moved into view out of a redundant pelvic colon. This is shown on the spot roentgenograms in the insert at the left upper corner. On subsequent examinations including air injection, the phenomenon repeated itself, proving that multiple barium enema studies with multiple spot roentgenograms are more dependable than one single examination by a routine method or some special technique.

enemas (Fig. 9, *A* and *B*).

Usually the following procedure is observed:

(a) When the enema reaches the rectosigmoid, the flow is stopped, and a spot roentgenogram is made of the area. The enema is then released to permit its advance to the junction of the sigmoid and descending colon, at which point it is again stopped so that additional spot roentgenograms and a conventional roentgenogram in the oblique projection may be taken from this area (Fig. 10).

(b) Over-the-table roentgenograms in oblique projection of the sigmoid are not, as a rule, made at the first examination because the colon usually is filled with some fecal residue.

(c) A spot roentgenogram is made of the splenic flexure.

(d) At the first examination, the barium enema study is frequently terminated at the proximal transverse colon to prevent spillage into the ileum.

(e) A posteroanterior roentgenogram is made with high voltage technique (120 kv).

(f) Another roentgenogram with the ordinary technique is made after the patient has had all the time necessary for evacuation.

High Voltage Technique. This consists of exposures with 115–120 kv. for the fluoroscopic spot films, which is superior to the usual 85–90 kv. technique, particularly in large patients.

Review of Roentgenograms. The initial roentgenograms are reviewed at this stage for (1) suggestive areas, (2) the quality of the results of the technique, and (3) the determination of the special views necessary during the second examination.

SECOND EXAMINATION

The second barium enema study is carried out immediately after evacuation of the first barium enema. This is done to provide confirmation of a negative shadow or abnormality recognized at the first examination as well as to clarify any doubtful area.

The bowel usually is better cleansed at the second examination because the tannic acid in the clysma employed for the first examination induces complete evacuation. It does happen, however, that the sigmoid which was clean at the first examination may contain fecal matter which moved from the cecum to the left colon while the patient was emptying the first clysma. A method of syphoning the sigmoid content would be advantageous in overcoming this problem.[30]

The procedure of the first examination is repeated at the second examination. It is important, after the enema has started to flow, to allow it to advance only slowly so as not to overdistend the rectum and sigmoid. Spot roentgenograms of the sigmoid

and flexures are made in the oblique, upright, supine, prone and even Trendelenburg positions, depending on the findings of the first examination.

Over-the-table oblique 10 by 12 inch roentgenograms are useful when any doubt remains after the other examinations. Fluoroscopy and spot roentgenography in the oblique views may prove extremely valuable in a small lesion that could not be visualized in a direct anteroposterior or posteroanterior projection (Fig. 7 *C*).

After the colon has been completely filled, a 14 by 17 inch roentgenogram is taken before evacuation. The postevacuation roentgenogram is made after the patient has had as much time as necessary for evacuation.

Chassard-Lapiné View. The Chassard-Lapiné view of the pelvis and lateral views[1] of the full rectum and colon are employed when the clinical symptoms or the initial examination warrant. Because of lack of contrast, the Chassard-Lapiné view has not always been successful in our series.

AIR INSUFFLATION

Indications. The so-called routine roentgenograms are reviewed at this time to decide whether an examination with air insufflation is indicated *on the same day*. The factors that influence the decision are: (1) the age of the patient and his ability to withstand the insufflation of air on the same day or even the next day; (2) the ability of the patient to tolerate a second dose of castor oil on two successive days; and (3) the place of residence of the patient and his ability to return for re-examination.

Patients having coronary disease or other disorders of the heart must be treated cautiously. It may be prudent to forego the use of air insufflation in such patients entirely, although so far no untoward episodes were observed. If the patient is aged, infirm, or inordinately uncomfortable after insufflation, a tube is placed in the rectum to remove the air through a water-filled pail.

When the patient cannot return on the second day, examination is completed on the first day, provided there has been adequate cleansing of the bowel as a result of the two successive enemas that the patient has already had. If the colon has been adequately prepared, as indicated by the appearance after the second enema and nothing suggests the presence of polyps, the radiologist need not hesitate to inject the air on the day of the original examination.

Whether air contrast study is made on the first day or on a re-examination the next day, enough barium should be present in the colon to produce a double contrast. If the barium is insufficient an additional amount is injected, using a double purpose jar which is then turned 180 degrees without removing the enema tip, and air is insufflated.

Results. Examination using air insufflation can succeed when routine roentgenograms fail to outline a lesion (Fig. 11, *A* and *B*). Conversely, air roentgenograms can result in nonvisualization, notwithstanding unequivocal demonstration of the polyp in the barium-filled colon (Fig. 11, *A* and *B*, and Fig. 12). It is impossible to ascertain in advance whether the barium-filled colon, the mucosal contour or the air contrast will give the positive findings. Unmistakable polyps and even large annular carcinomas, particularly in the sigmoid and cecum, sometimes are not demonstrated in good air contrast roentgenograms. Overdistention and overlapping frequently seen in those areas, particularly when air has been employed, cause the difficulty. On the other hand, the air-filled rectum often makes possible demonstration of a lesion when the barium-filled rectum or cecum fails to do so.

Despite every precaution and careful technique, apparently an element of chance persists, for one cannot explain why a polyp will be coated and can be visualized on some occasions, whereas on others, it cannot be recognized (Fig. 6, *A* and *B*, Fig. 11, *A* and *B*, and Fig. 12).

Roentgenographic Procedures. The routine procedure includes an anteroposterior and

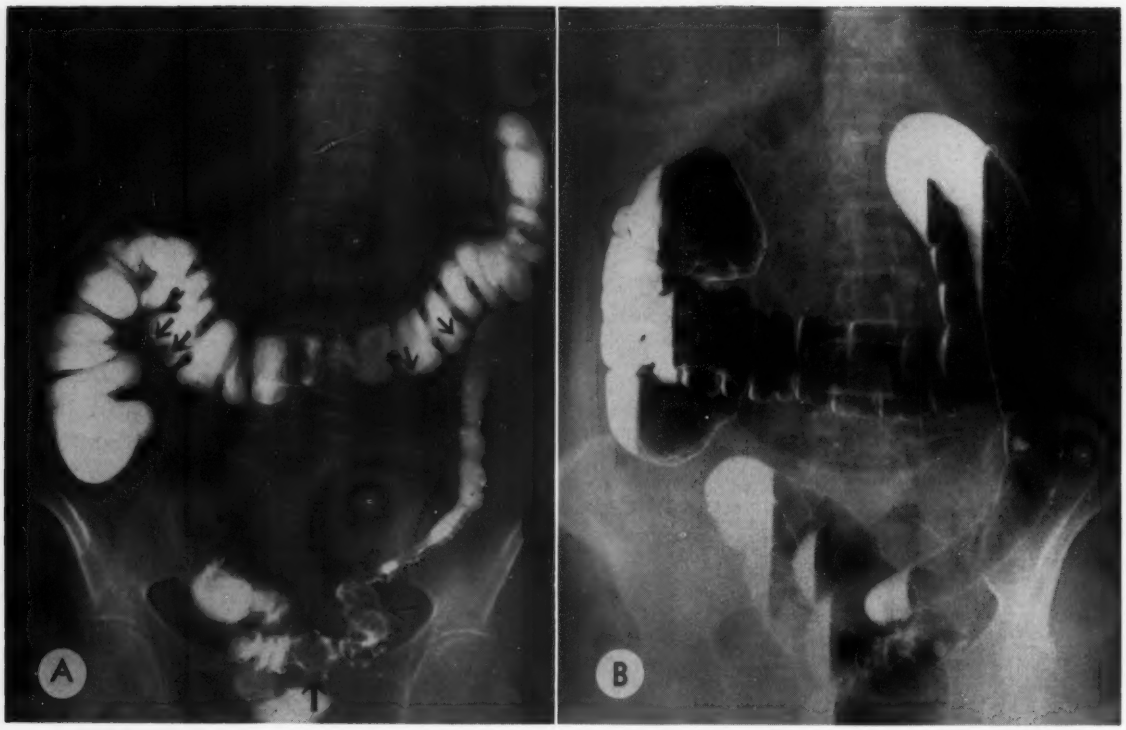

Fig. 11. (*A*) There are two obvious polyps in the sigmoid (in an area of diverticulosis) (lower arrows). A positive diagnosis of many small lesions in the transverse colon is possible only by persistence of appearance (upper arrows) on repeated roentgenograms taken during the first day's examination as well as on re-examination at a later date. (*B*) Air insufflation did not adequately outline the small polyps in the transverse colon on the second day of examination. Overdistention of the colon causes minute polyps to be flattened and therefore become unrecognizable. Polyps sometimes do not take coating of barium; they can be visualized, if at all, only as structures surrounded by air.

a posteroanterior (both in the supine position), an oblique, and two upright roentgenograms, one in the posteroanterior and the other in the lateral position. Any one of these can disclose a polyp or even its stalk,[38] which may be considered almost pathognomonic, when visualized in the lateral projection or by the doughnut appearance (polyp with stalk on end[19]) as seen in the posteroanterior projection.

On rare occasions, a knee-chest position is used for a lateral projection of the rectum. In this position, the air in the colon tends to rise to the highest point, which is the rectum.

The lateral view upright roentgenogram may bring into silhouette a diverticulum, thus helping in the differential diagnosis between diverticulum and polyp (Fig. 13, *A* and *B*). The inspissated barium in a diverticulum, particularly at the second day's examination, is of value in this respect. The relation of a hypertrophied ileocecal valve to the terminal ileum can sometimes be demonstrated in multiple oblique views. Also, the possible presence of a polyp in this region may be ruled out in this manner.

Rarely, in the presence of multiple large diverticula and marked spasticity, a twenty-four hour roentgenogram of the abdomen may provide differentiation between a diverticulum and a polyp (Fig. 14).

ALTERNATIVE ABBREVIATED PROCEDURES

When circumstances call for shorter procedures, two simplified methods of examination may be employed.

In one method a thin barium mixture, containing tannic acid is used in a clysma (3 ounces to 1,000 cc.) as a cleansing enema.

A roentgenogram is taken to determine the distance to which this type of enema had advanced. If the colon is exceptionally full of fecal matter, a second thin barium enema of the same type is given, after which fluoroscopy of the colon is begun. A single examination is made. Roentgenograms before and after evacuation as well as several spot roentgenograms are taken.

The other method, which is employed more frequently, calls for a preliminary roentgenogram and a routine barium enema study with roentgenograms as indicated. If there is a great deal of fecal matter, the technician gives a second enema to the patient, but this is not followed by fluoroscopy. Instead, the technician takes roent-

FIG. 12. Small polyp in sigmoid visualized on a post-evacuation roentgenogram shown in insert at left upper corner (arrows). Recognition uncertain on roentgenogram of air-filled colon.

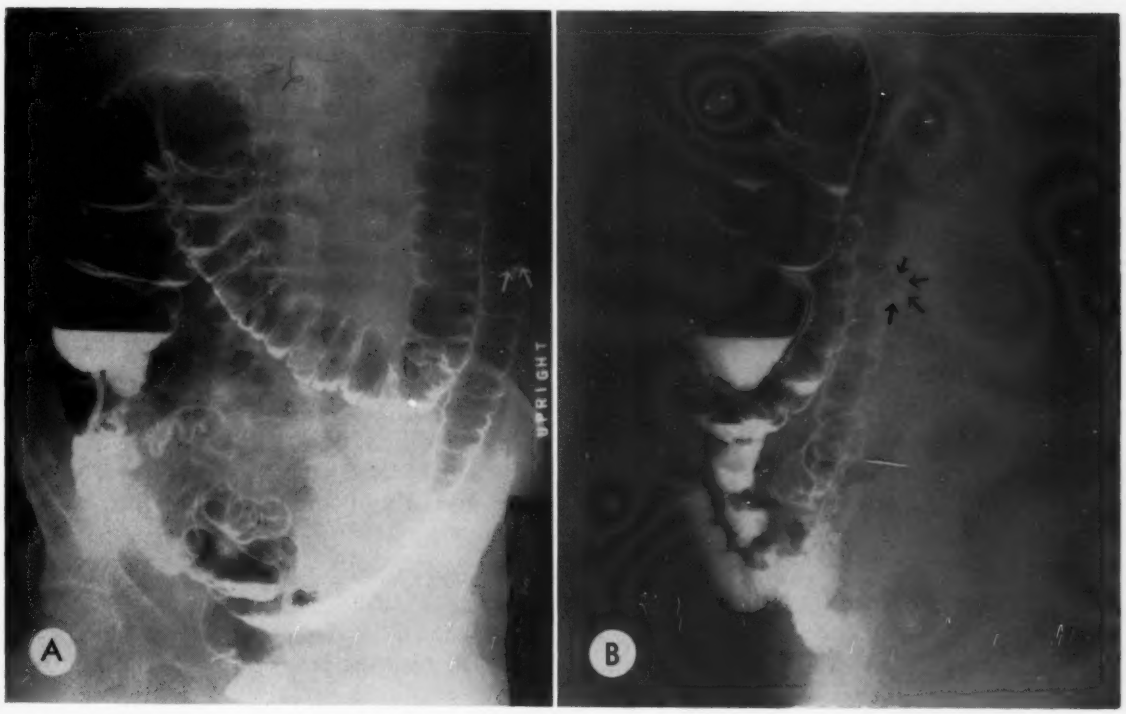

FIG. 13. (*A*) Posteroanterior upright roentgenogram shows the fluid level in a diverticulum (arrows). (*B*) Lateral upright roentgenogram shows the diverticulum beyond the lumen of the bowel with a fluid level within it. Upright roentgenograms, particularly in the lateral view, have been useful in differentiating polyp from diverticulum.

Fig. 14. Confirmatory evidence of a polyp believed to be present (arrows) was obtained by the twenty-four hour roentgenogram. Patient had severe diverticulitis and spasticity which made visualization of the polyp on a barium enema study extremely difficult.

genograms before and after evacuation.[37] Two sets of roentgenograms after two enemas are thus available.

A report of "probably negative colon" seldom results when the patient has had the benefit of adequate cleansing or of a two-enema examination. If no *constant* defect is found on repeated examinations, a negative diagnosis may be made with certainty. Any defect, no matter how small, must be approached with a *high degree of suspicion* if the patient's colon is free of fecal matter.

COMMENTS

Confirmatory Examinations. If the history of the patient suggests that he has a polyp accessible to direct visualization or if a polyp has already been demonstrated elsewhere, it is preferable that the re-examination be made after the second enema so as to have the advantages of further dietary regimen, the cleansing agent that was employed for the original examination with barium, and an additional dose of castor oil. This procedure is dictated by the knowledge that polyps are frequently multiple in number (Fig. 11, *A* and *B*).[15,19,26,35] The method of examination should be determined on the basis of the findings of the first examination.

Hazard of Bag in the Rectum. A bag in the rectum may prevent an accidental expulsion of the barium suspension on the table, but it is not without hazard. A few cases have been recorded of rupture of the bag. Or, a patient may die suddenly after the barium enema administration as has happened in a personal case. A woman from whom the bag had been removed and who was apparently in satisfactory health and able to leave the roentgenographic table unassisted to the cart died suddenly. Postmortem examination offered no explanation. It appeared that death was caused by elevation of the diaphragm and change in position of the heart rather than by a vagovagal reflex or cardiac arrest. Recurrent cervical carcinoma with obstructed neck of the bladder was an incidental finding.

Mechanical Aids to Interpretation. It is advantageous to use a code number or letter for each segment of the colon and then mark not only one of the 14 by 17 inch roentgenograms but also the spot roentgenograms with the same code; thus, when one checks points *A*, *B* and *C* on the roentgenogram of the entire colon, he immediately sees points *A*, *B* and *C* on the spot roentgenograms for comparison.

A battery of eight view boxes so that most of the roentgenograms can be placed side by side and compared simultaneously is another helpful adjunct.

CONCLUSIONS

1. It is important that the examiner realize his responsibility when roentgenologically studying the colon. Many patients have a great deal at stake. Therefore, each examination should be approached with a high degree of suspicion rather than with the indifferent concept that all is well un-

less somehow proved otherwise.

2. Adequate preparation of the patient is paramount. Only 24–29 per cent of the patients, both hospital and private, are satisfactorily prepared when they arrive at the radiologic department. This figure rises to 63–78 per cent when a two-barium enema method is adopted. In a series of more than 500 cases studied by this method, adequate preparation was observed at the first examination in 25 per cent and at the second examination in 75 per cent of the cases. Achievement of success lies in the immediate successive performance of the two barium enema examinations.

3. The barium column in each segment of the colon, particularly the sigmoid, must be of such density that it is readily penetrated by the roentgen ray beam, otherwise the examination will remain unsuccessful.

4. Overdistention of the colon should be avoided especially in the rectum and sigmoid, where control of the degree of distention is possible.

5. A satisfactory contrast should be present for spot roentgenography. In this respect, a stationary or moving grid on the fluoroscope seems almost indispensable.

6. The barium suspension used for mucosal studies should contain tannic acid or an equivalent substance; this helps to empty the colon of barium in preparation for the second barium enema examination which is to follow or for the air insufflation study that may be contemplated.

7. Positive findings must be confirmed by re-examination on another day.

8. All acceptable procedures must be utilized in whole or in part with proper discrimination and well considered selection. No one procedure has been uniformly successful. This applies to fluoroscopy, full colon roentgenography, mucosal pattern studies and air contrast examinations.

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A NEW METHOD OF AIR CONTRAST EXAMINATION OF THE COLON FOR ROUTINE APPLICATION*

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DEFICIENCIES in the barium enema examination of the colon occur in many patients. These are due to poor preparation of the patient or to incomplete visualization of the colon by this procedure.

Inadequate preparation results in retained fecal material which frequently raises the question of polyps and necessitates re-examination. Fecal material lodged in the cecum may also cause filling defects that cannot be excluded as pathology. Oil "polyps" occur when the patient is prepared with castor oil, and real polyps hide under the shadow of barium.

Roentgenographic visualization may be impaired as a result of redundant bowel obscured by barium-filled loops and this may cause the radiologist to question whether or not he has visualized every portion of the bowel completely. In addition, incomplete filling of the cecum occurs inadvertently, and areas of spasm may appear roentgenographically and resemble organic lesions.

Even the most thorough preparation does not eliminate the problem of factitious filling defects, nor has it any effect on the remaining deficiencies; and fluoroscopy and spot roentgenography will not obviate all problems of incomplete visualization arising from redundant bowel.

A very important complement to the barium enema examination for demonstrating the presence or absence of pathology is the double contrast enema study.

Objection to routine use of the air contrast method may be expressed. The reluctance to use routine pneumocolon studies stems partly from the difficulty of obtaining statisfactory air-filling of the colon except by fluoroscopic control, which is time-consuming and entails prolonged dark adaptation, and partly from the fact that, when this examination is performed in the usual way, the added cost of roentgenographic films, processing, radiologist's and technician's time, and equipment depreciation are significant. Inasmuch as a complete air contrast study on every colon would be impractical, an abbreviated air contrast procedure requiring no fluoroscopic control and employing only one additional roentgenogram would be a practical and helpful supplement to the barium enema examination. This will provide certain of the advantages of the usual double contrast enema without many of the inconveniences.

A NEW APPLICATION OF THE AIR CONTRAST PROCEDURE

Following the usual careful fluoroscopic and roentgenographic examination of the barium-filled colon, a measured quantity of air is instilled slowly into the colon by the technician in an amount approximately equal to the volume of barium used. This quantity may be determined by one of two methods. (1) By using a calibrated enema container, the volume can be read directly. (2) By weighing the barium used for the barium enema, one can obtain the volume in the following manner: The enema container is suspended from a gram scale during the examination, and the difference in weight before and after the examination is read. Since the specific gravity of the barium suspension is only about 1.05 to 1.07, the weight of the mixture used may be converted directly to cubic centimeters without appreciable loss in accuracy.

Air may be instilled into the colon by means of a calibrated syringe or other special equipment, but one of the simplest methods is to use a rubber insufflation

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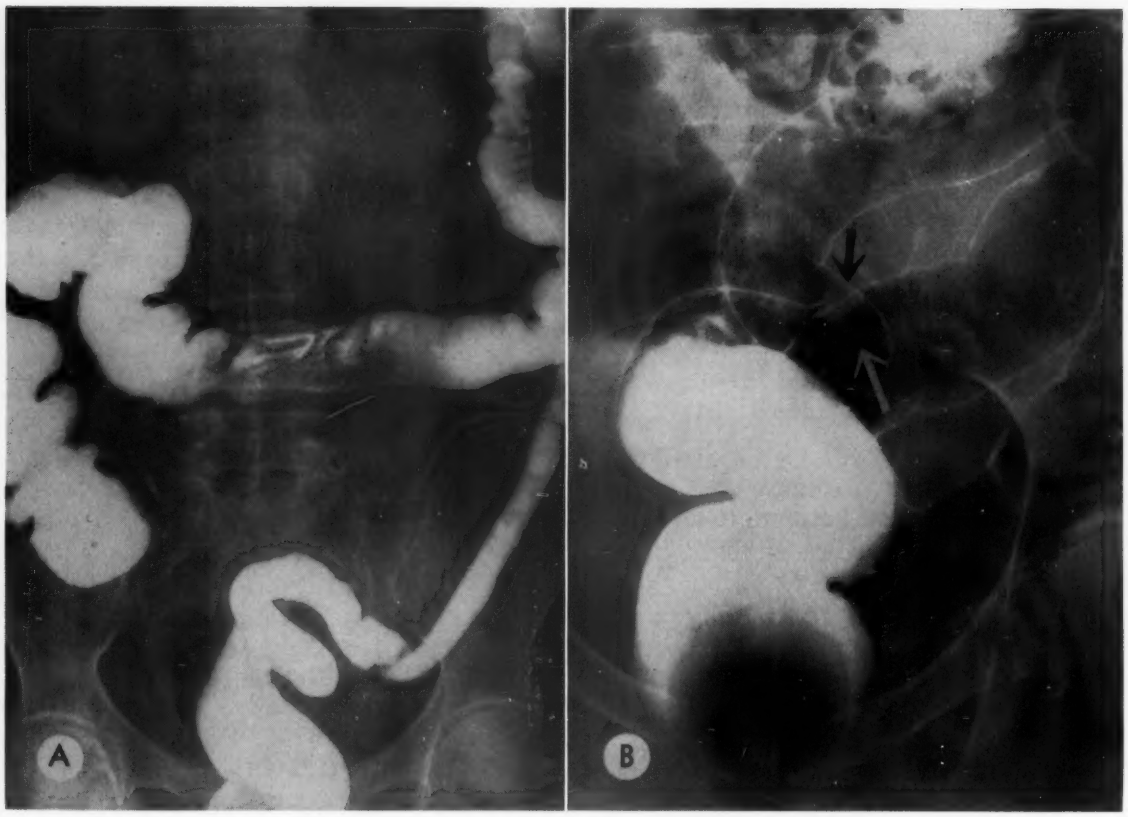

Fig. 1. (*A*) The barium filled colon showing no abnormality. (*B*) Routine posteroanterior air contrast study revealing polyp.

bulb, the volume of which has been determined by water displacement. In this study, the bulb used delivered 30 to 35 cc.of air depending on how it was squeezed. If the amount of bowel distention is more or less than desired by the individual radiologist, he may increase or decrease the amount of air used to suit his requirements. A single posteroanterior roentgenogram is now made to complete the abbreviated air contrast examination.

Reflux of barium through the ileocecal valve into the distal ileum during the barium enema study frequently obscures the sigmoid portion of the colon, and an effort is made, therefore, to empty the barium from the ileum by having the patient drink two 12 ounce glasses of water at fifteen minute intervals immediately after the patient has evacuated. The instillation of air in the colon is begun approximately thirty minutes after the second glass of water. This method of removing the barium from the ileum has been found to be successful in 60 to 70 per cent of cases, and partially successful in another 20 per cent. At the same time, when Carmethose* has been added to the barium suspension, the flocculation of barium is not significant in spite of the prolonged time interval following evacuation of the barium enema.

Danger of the Double Contrast Study. Too rapid air insufflation may result in rupture of the bowel, particularly in the presence of a diseased colon, as reported in the medical literature.[1] The radiologist must be aware of this and should instruct his technician to introduce the air slowly. The patient may evacuate the barium incompletely. In such a case, overdistention may result if all of the measured air were to be introduced. Overdistention may be avoided in two

* Brand of carboxymethylcellulose; Ciba Pharmaceutical Products, Inc., Schmidt, New Jersey.

ways: (1) by inflating the colon slowly and discontinuing if the patient voices more than the usual complaint; or (2) by utilizing a less practical method, *i.e.* checking the postevacuation roentgenogram prior to instillation of the air and, if evacuation is poor, instructing the technician to decrease the air used in an amount estimated to equal the retained barium. In 1,027 cases, the author has experienced no complications by the use of this method.

RESULTS

A more informative examination of the colon has resulted from the use of a routine air contrast examination after the usual barium enema study with more complete visualization of the large bowel and with a decrease in the number of re-examinations necessary. Re-examinations were occasionally required by questionable polyps shown by the double contrast examination when in actuality no polyp was present. On the other hand, several polyps were found which otherwise would have been missed by the usual barium enema examination (Fig. 1). Areas of narrowing and of incomplete filling seen on the roentgenograms of the barium enema were shown on the pneumocolon roentgenogram to be well distended with air excluding organic pathology. Loops of air-filled colon provided "windows" through which redundant bowel, previously obscured by barium, could now be seen. The amount of air distention of the colon was satisfactory in 88 per cent of the cases. The failures were due to mathematical miscalculations of the volume of barium used and/or the patient's inability to retain the air resulting in incomplete filling. It is partly for this reason that this limited method of double contrast examination is not recommended when there is any suspicion of polyp formation by the clinician, or when one is suggested by a history of melena. In these instances, the air is introduced into the colon under fluoroscopic control, and spot roentgenograms are used along with a much more extensive roentgenographic examination.

CONCLUSION

A convenient and inexpensive method of abbreviated double contrast examination of the colon as a complementary procedure to the barium enema is advocated in routine cases to provide a more informative study and to decrease the need for re-examination. In the presence of melena or suspected poyps the usual manner of double contrast examination is recommended.

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SIX PRIMARY ADENOCARCINOMAS OF THE COLON OCCURRING SIMULTANEOUSLY

REPORT OF A CASE

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THE occurrence of multiple primary malignant tumors in an individual or within a single organ has aroused increasing interest in the literature during the past decade. It is believed that the incidence of subsequent malignancies in patients with one cancer is greater than the incidence of malignancy in individuals without cancer. Studies based on large numbers of collected cases show that the average incidence rate of multiple malignant lesions of the colon is between 3 and 4 per cent. It is generally felt that the incidence is higher than would be indicated by chance alone. Old age apparently is not a factor in the occurrence of multiple lesions, since the mean age for such patients is less than for patients with single lesions.

Adenomatous polyps are believed by many authors to be precancerous lesions because of the higher incidence of benign polyps associated with malignancy (42 per cent) than with the cancer-free colon as found in routine autopsy series (from 2.4 to 9.5 per cent). A familial history of colon cancer was present in 54 per cent of the patients who harbored both carcinoma and benign polyps. These studies indicate that predisposition or "inherent susceptibility" to cancer seems to be the most important single factor in the production of multiple malignant lesions of the colon. It is also quite possible that malignant cells shed from a primary tumor of the colon may be implanted anywhere in the mucosa, thus initiating the growth of a new tumor.

Lahey stated that there has not been sufficient awareness of the possibility of multiple lesions of the large bowel. According to Thomas, Dockerty and Waugh,[21] about 50 per cent of the multiple lesions were undetected if the lesions occurred in the same segment, and between 40 and 55 per cent of coexisting tumors that involved different segments were not diagnosed before operation. Berson and Berger[2] call attention to the frequency with which the second lesion is overlooked at surgery. These authors emphasize the difficulty in palpating the coexisting lesions at surgery even when they are situated in the same segment. In 3 cases of the 16 reported by these authors it is noteworthy that the second lesion was recognized only at inspection of the removed specimen, with the unsuspected lesion often located several centimeters away from the known tumor. They advise wide excision in order to avoid the possibility of leaving behind a second lesion in the colon.

The following is a report of 6 carcinomas of the colon occurring in a diabetic patient simultaneously, who had had another primary malignant tumor removed nine years previously.

REPORT OF A CASE

S. 53–484. A.M., a seventy-five year old white female, was hospitalized on February 22, 1953 with symptoms suggesting intestinal obstruction. According to the hospital records, this patient was first admitted in February, 1944, with a two year history of vaginal bleeding, and at that time was found to have diabetes.

There was no history of malignancy in the family. On February 21, 1944, a dilatation and curettage was performed and the endometrium showed adenocarcinoma Grade II. Because of her poor physical condition, it was decided that surgery was not advisable. In February, 1944 she received a radium dose of 4,500 mg. hours. From May 10 to May 31, 1944, 4,600 r of deep

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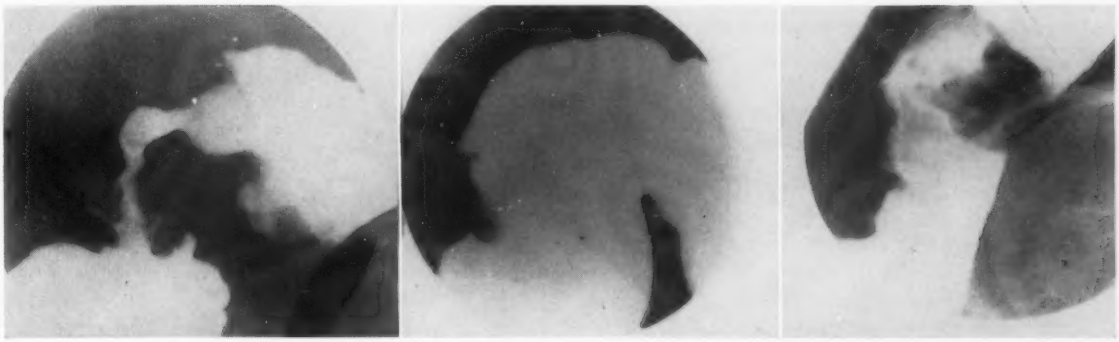

Fig. 1. Spot roentgenograms demonstrating the lesions at the hepatic flexure, distal transverse colon and in the sigmoid.

roentgen therapy was delivered to the pelvis. On September 22, 1944, she received an additional 2,000 mg. hours of radium to the uterine cavity, thus providing a total radiation of 6,500 mg. hours of radium and 4,600 r by deep roentgen therapy. On December 4, 1945, a panhysterectomy was performed. The pathologic report showed well differentiated papillary adenocarcinoma of the uterus.

When admitted on February 20, 1953, she complained of having had mid-abdominal pain the preceding month, associated with nausea and vomiting during the last three days. Due to her increasing constipation, she had been taking laxatives daily during the past year.

A supine roentgenogram of the abdomen on the day of admission showed markedly distended ileal loops as well as distention of the proximal colon. Numerous fluid levels were seen within the small and large bowels on the upright roentgenogram.

Physical examination was not remarkable with the exception of the abdomen which was moderately distended and tympanitic, with a 20 by 10 cm. umbilical hernia. Pelvic examination showed a well-healed vaginal apex. No masses or induration were palpable. Rectal examination and sigmoidoscopy up to 20 cm. were not informative. The blood chemistry findings and electrocardiogram were normal.

A Miller-Abbott tube was passed beyond the ligament of Treitz. The abdomen became decompressed during the following two days and on February 25, 1953, a barium examination was done. This showed a polypoid mass involving a 5 cm. long segment in the mid portion of the elongated sigmoid. There was another small mass in the region of the splenic flexure. A 7 cm. segment of the hepatic flexure narrowed down to an irregularly outlined, rigid channel, causing delay in filling of the ascending colon with barium. Spot roentgenograms taken of these 3 lesions showed the details of the tumors (Fig. 1). The 14 by 17 inch roentgenograms of the filled colon (Fig. 2) demonstrated another rounded mass 4 cm. in diameter at the medial aspect of the cecum which was believed to represent lipoma of the ileocecal valve. The advanced lesions in the hepatic flexure and in the sigmoid were obscured because of the tortuosity of these segments.

The prompt emptying of the colon permitted the immediate follow-up examination by air

Fig. 2. Appearance of the barium filled colon on a roentgenogram taken after the examination. Of 6 malignant lesions, only one, which is located in the splenic flexure, can be traced on this roentgenogram.

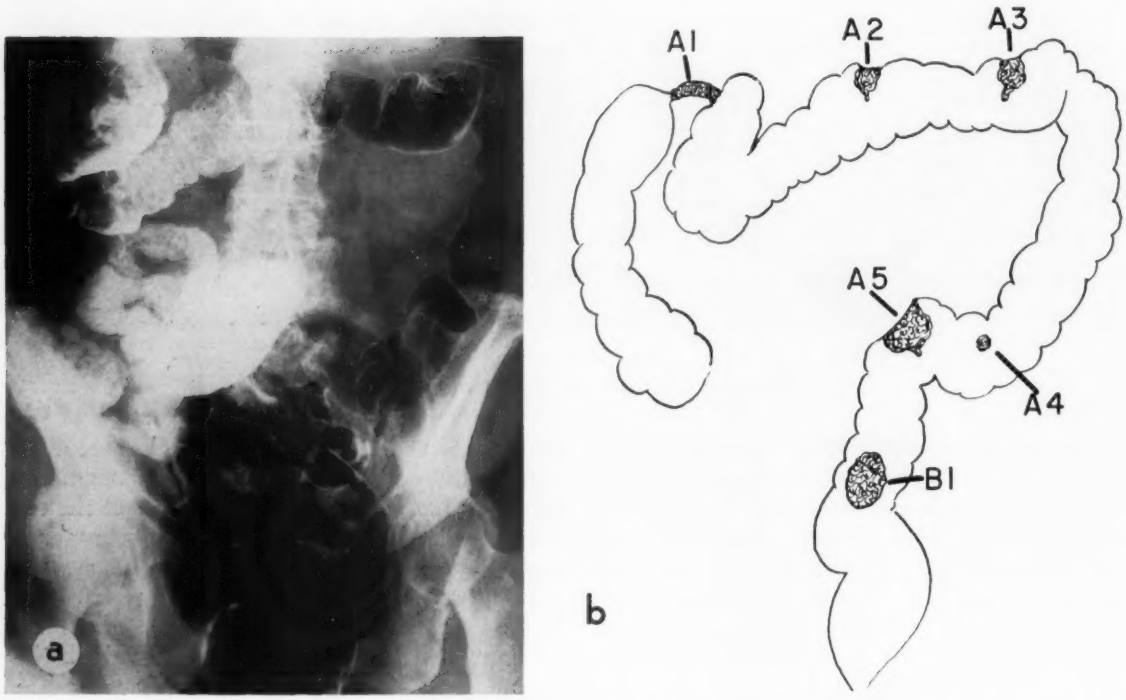

Fig. 3. (*a*) Roentgenogram taken after the air contrast study of the colon showing, in retrospect, all 6 lesions found on the specimen. (*b*) Line drawing of the colon demonstrating the distribution of the 5 carcinomas (A1 to A5) in the surgical specimen, and the sixth tumor (B1) in the rectosigmoid found at autopsy.

contrast study. Two additional polypoid lesions were visualized, one in the proximal sigmoid and another in the region of the mid-transverse colon (Fig. 3*a*).

Laparotomy was performed two days later. At surgery only four lesions were palpable besides the mentioned lipoma in the ileocecal region. Although a total colectomy was contemplated, due to surgical complication the procedure had to be terminated after the resection of all of the colon proximal to the mid-sigmoid. The patient expired on the same day. The distal half of the sigmoid and the rectum were examined at autopsy.

Inspection of the gross surgical specimen showed five polypoid lesions of the colon in addition to the lipomata of the ileocecal valve and cecum (Fig. 3*b*). The tumors showed great variation in size, measuring from 1 by 1 by 0.5 cm. to 4.5 by 4 by 1.3 cm. The autopsy specimen of the rectum and distal half of the sigmoid demonstrated an additional polypoid mass (B1 in Fig. 3*b*) measuring 4 by 3 by 1 cm. Careful searching failed to reveal any adenomatous polyps of the colon.

DISCUSSION

It is interesting to note that the most advanced carcinoma in the hepatic flexure was the most proximally located, implicating cellular seeding as a possible explanation for the development of the smaller sized and less advanced lesions in the left side of the colon.

A review of the literature showed several instances of 3 or 4 lesions reported as occurring simultaneously. Marshak[15] described a case with 5 carcinomas present in the colon. There are a few cases published in the asynchronous group with more than 4 lesions; however, in these cases the tumors developed and were diagnosed over a span of several years. Stalker and co-workers[19] reported a case with 4 nonsimultaneously occurring lesions found over a two year period, which had been removed separately. In Doland's[8] case the 4 reported adenocarcinomas of the large bowel and one of the

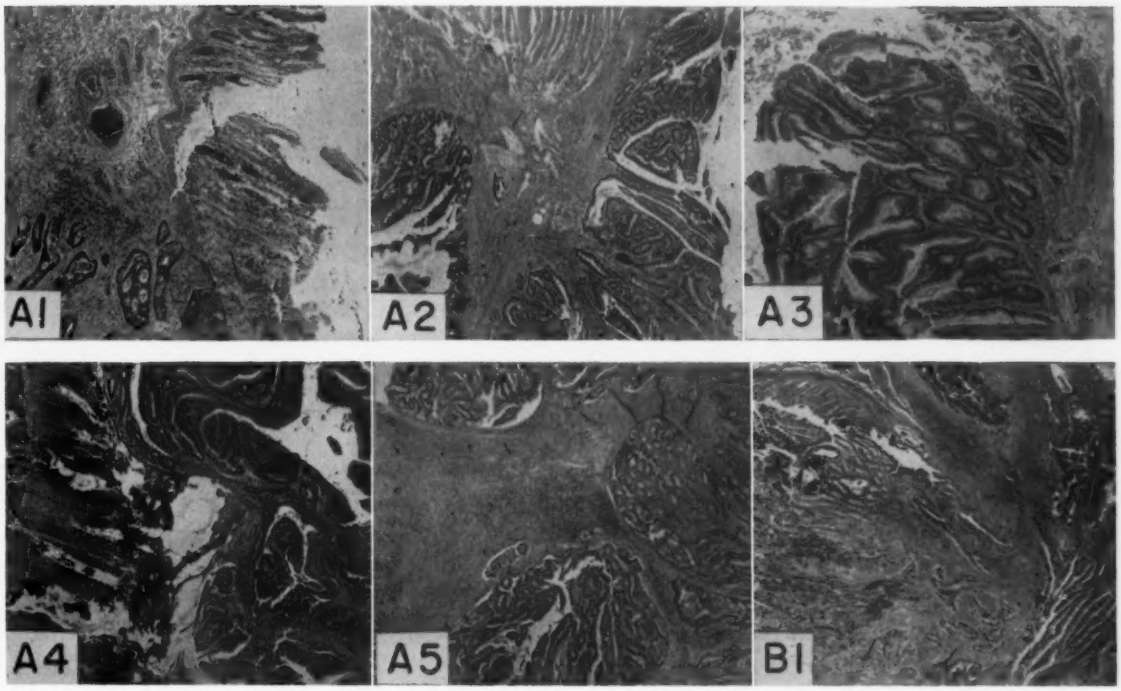

Fig. 4. Microscopic findings of the 6 carcinomas of the colon. The identifications of the sections correspond with the numbering marks of the line drawing on Figure 3*b*: (A1) adenocarcinoma of the colon involving all coats; (A2, A3 and A4) adenocarcinoma of the colon not involving the muscular coat; (A5 and B1) adenocarcinoma of the colon with invasion of the muscular coat.

terminal ileum were removed over a period of eighteen and one-half years.

SUMMARY

A case is reported, with 6 primary adenocarcinomas of the colon, all simultaneously present. There was no evidence of concomitant adenomatous polyps on the removed specimen. Attention is called to the greater incidence of a second primary malignancy in persons who have had one cancer. No other similar case report could be found in the English literature.

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SIGMOID VOLVULUS*

VARIATIONS IN THE ROENTGEN PATTERN

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SIGMOID volvulus is the cause of at least 2 per cent of all cases of intestinal obstruction, with a mortality of approximately 25 per cent in the operated cases and 100 per cent in the nonoperated cases in which the torsion fails to reduce spontaneously. If this high mortality is to be reduced the diagnosis must be made earlier in a greater percentage of cases. Thus only can one avoid attempts at protracted and, at times, disastrous catharsis, temporizing intubation, and cecostomy, which may result in strangulation of the volvulated loop with necrosis, rupture and peritonitis.

It is the purpose of this paper to discuss the roentgen features of this condition and to emphasize those findings which should alert the examiner to the possibility of pathologic sigmoid torsion, especially the atypical forms.

INCIDENCE

Sigmoid volvulus has been observed with much greater frequency in European countries, particularly among the Russian, Siberian and Scandinavian peoples than in this country. Frimann-Dahl[7] studied 250 cases roentgenologically during a twelve year period. Of 215 cases of intestinal obstruction reported by Perlman, from a Russian surgical clinic, 111 were cases of volvulus. Obalinski found 19 cases of sigmoid volvulus among 110 cases of intestinal obstruction. At the Massachusetts General Hospital, Sweet reported 10 cases of sigmoid volvulus occurring in 520 cases of obstruction. Griffin and his associates[9] found 37 cases of sigmoid volvulus in a series of 458 cases of colonic obstruction treated between 1937 and 1945 at the Cook County Hospital. Becker[2] recently reported an incidence of 45 cases of sigmoid volvulus occurring in 31 patients in a series of 205 cases of acute obstruction of the colon at the Charity Hospital of Louisiana, during the years 1940–1949.

Excessively bulky vegetable diets are thought to be an important contributory factor in the more frequent occurrence of sigmoid volvulus among the Russian, Siberian and Scandinavian peoples. It has been observed also in this country that sigmoid volvulus occurs more frequently in inmates of mental institutions and of homes for the aged, as well as in the Negro race. Chronic constipation, poor bowel habits and high residue diets undoubtedly play an important part in the higher incidence in these groups.

CLINICAL FEATURES

In younger age groups, sigmoid volvulus may develop rapidly with a relatively quick onset of generalized cramping abdominal pain and early vomiting. Usually, there is no history of previous attacks nor of annoying constipation. The disease may develop its full pattern in less than twenty-four hours. In the older age groups the onset is notably slower. There may be a history of previous attacks and chronic constipation, and cramping lower abdominal pains associated with vomiting may not appear until the fourth to sixth days, so that the patient is not seen by a physician before several days have elapsed from the onset of the illness.

A long and freely movable sigmoid loop, either congenital or acquired, is necessary for the occurrence of sigmoid volvulus. The more closely approximated are the basal fixation points of the sigmoid loop to the posterior abdominal wall, the more easily can the redundant loop rotate on its narrow base. Intestinal obstruction due to sigmoid volvulus may vary somewhat since the

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proximal or the distal component of this loop may undergo torsion or both limbs may participate in the pathologic rotation. The latter mechanism occurs most frequently.

ROENTGEN FEATURES

The diagnosis of sigmoid volvulus can be established in the great majority of cases by suitable roentgenologic study. Classically, cases of sigmoid volvulus present these features: (1) A severe distention of the sigmoid flexure, which, rising from the pelvis, may extend to the edge of the liver or reach the diaphragm; and (2) marked accumulation of fluid in the obstructed sigmoid loop. Fluid levels can readily be demonstrated in the ascending and descending sigmoid segments while the patient is in the erect or appropriate lateral decubitus position.

In our review of approximately 45 cases with roentgen studies, we were impressed with the following features: In the typical case (60 to 70 per cent of the series) the obstructed sigmoid loop was predominant in the abdomen, usually with a complete loss of haustrations. The ascending and descending components of the sigmoid were clearly outlined and the appearance was quite characteristic and pathognomonic. In the remaining cases (30–40 per cent of the series), the distended sigmoid deviated to either the right or the left flank. Very often, in spite of partial or complete superimposition of the ascending and descending sigmoid limbs, the involved colonic part could be recognized as sigmoid and an actual diagnosis thus was possible. In an occasional case when the sigmoid loop deviated to the left and there was severe distention of the remainder of the colon and small bowel, it was extremely difficult to recognize a severely distended and abnormally rotated sigmoid as the primary cause of obstruction. In these cases a barium enema contrast study of the colon was necessary to aid in the differentiation of the cause of obstruction. It is in this latter group that suspicion of volvulus should be strongly entertained. The observer should seriously attempt to make a definite diagnosis, in order that proper surgical treatment may be instituted early in the course of the disease. There are roentgen signs which will usually suggest the proper diagnosis. If, for example, one is able to identify multiple distended colonic segments rising in parallel out of the pelvis; *i.e.*, if one can identify the ascending and descending colon, but, in addition, is able to recognize other colonic segments rising from the pelvis and paralleling more or less the course of the ascending or descending colon, then one must suspect the latter to represent a pathologically rotated sigmoid. Demonstration of two or more fluid levels often extending over the entire length of the abdomen on lateral decubitus studies will strengthen the suspicion of sigmoid volvulus. A subsequent barium enema examination will establish the most caudad point of obstruction above the rectum and illustrate the effects of torsion on the mucosal pattern at or near the rectosigmoid junction.

TREATMENT

Treatment of sigmoid volvulus must consist primarily of detorsion and, secondarily, of some corrective procedure whereby recurrence can be prevented. In nonstrangulated cases many surgeons favor exteriorization of the long sigmoid loop with resection and secondary closure of the bowel. Others prefer plication of the mesentery with some attempt at wider separation of basal fixation points in an effort to prevent recurrence. Still others favor detorsion and elective resection with primary closure at a later date.

REPORT OF CASES

Case 1 (Fig. 1). J.B., a sixty-nine year old Negro male, was admitted on March 18, 1943 with severe abdominal pain, distention, nausea, vomiting and constipation of four to five days' duration. He had been hospitalized on several previous occasions with similar complaints. Each time his distress had been relieved by insertion of a rectal tube.

Roentgenologic Examination. March 19,

1943. A single severely distended, smoothly bordered loop arose from the pelvic cavity and extended through the greater portion of the abdomen to the lower margin of the liver and left diaphragmatic dome. There was no discernible accumulation of gas or fecal matter in any other intestinal segment. A diagnosis of sigmoid volvulus was made.

Diagnosis. Surgical exploration appeared undesirable as the patient's condition was very poor. A rectal tube was inserted and large amounts of gas and fluid fecal matter were eliminated. The patient expired on the succeeding day and at autopsy a gangrenous sigmoid loop with torsion of approximately 540° was found.

Comment. Severe distention of the sigmoid loop without accumulation of gas and fecal matter in other intestinal segments is seen rarely, but the appearance in this case must be regarded as pathognomonic of sigmoid volvulus.

Case II (Fig. 2, *A* and *B*). S.G., a fifty-two year old white male, was admitted on November 16, 1946 complaining of abdominal pain, distention and vomiting of three days' duration and constipation during this period.

Roentgenologic Examination. A severely distended sigmoid loop occupying the mid-abdomen, veering somewhat to the left was visualized; this loop was surrounded by distended colonic and small bowel segments. Sigmoid volvulus was strongly suspected. On contrast study of the colon, obstruction was encountered at the rectosigmoid junction with the mucosal pattern indicating twisting of the intestine at this level.

Surgery. On surgical exploration a 360° torsion of the sigmoid was discovered. Following detorsion the sigmoid mesentery was plicated. The patient was discharged as cured on December 5, 1946.

Comment. This case exemplifies a fairly typical roentgen pattern of sigmoid volvulus. Note especially the mucosal pattern at the rectosigmoid junction indicating conclusively obstruction due to volvulus.

Case III (Fig. 3, *A* and *B*). T.C., a seventy-six year old Negro male, was admitted on January 14, 1950 with abdominal cramps, pain, distention and vomiting. His history revealed increased constipation for two years.

Fig. 1. Case I. Note the severely distended sigmoid loop, which arises from the pelvis and reaches the left diaphragmatic leaf, and the striking absence of gas in other portions of the bowel.

Roentgenologic Examination. A severely distended double-limbed intestinal loop was found arising from the pelvis along the right flank to the lower margin of the liver. There was less severe distention of other intestinal segments and of the stomach along the left flank and left iliac fossa. A tentative diagnosis of volvulus of the sigmoid with deviation of the obstructed loop to the right flank was confirmed on contrast examination of the colon which illustrated a high-grade obstruction at the rectosigmoid junction, where the intestine was seen veering toward the right.

Surgery. Surgical exploration revealed a volvulus of the sigmoid with gangrene of this loop. A Mikulicz type resection with colostomy and secondary closure led to ultimate recovery.

Comment. This case represents deviation of the obstructed sigmoid loop to the right flank with superimposition of the ascending and descending limbs and torsion effects at the site of obstruction.

Case IV (Fig. 4, *A* and *B*). W.H., a thirty-eight year old Negro male, was admitted on

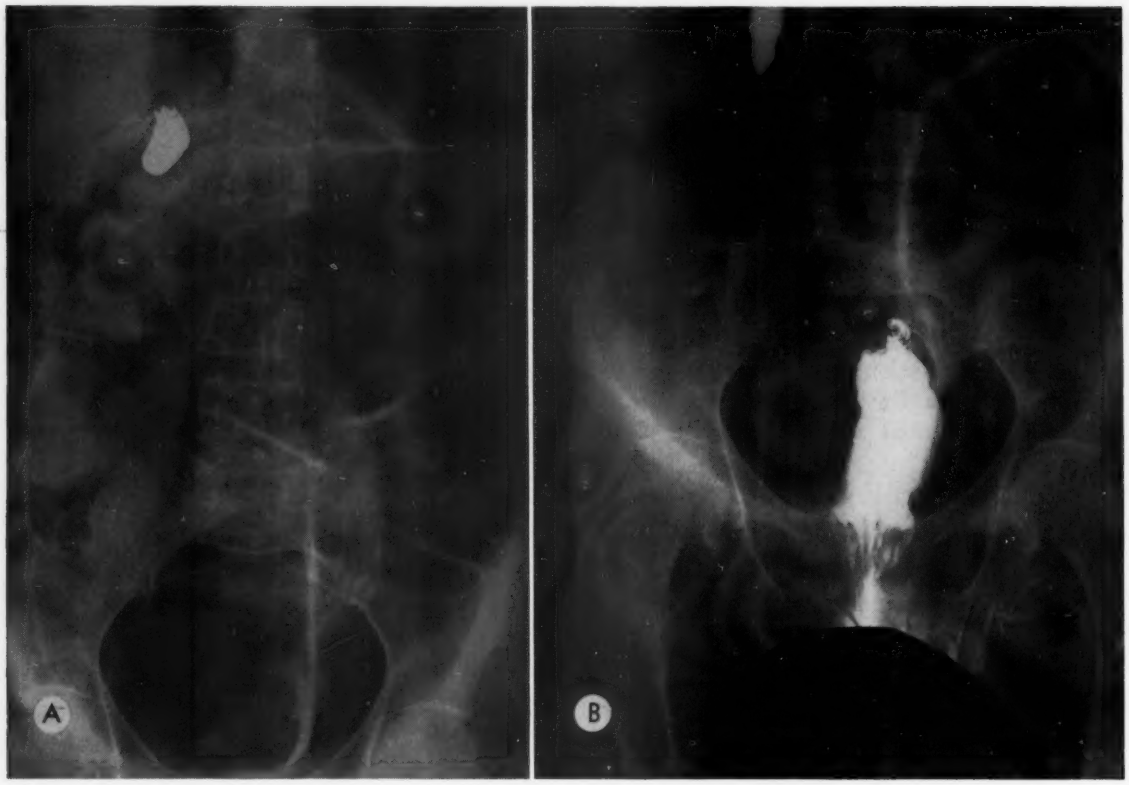

Fig. 2. Case II. (*A*) The sigmoid loop occupies the mid and lower abdomen, deviates slightly to the left and is surrounded by distended colonic segments. (*B*) Note torsion effect on the mucosa at the rectosigmoid junction.

December 14, 1949 complaining of generalized cramping abdominal pain, distention and vomiting of four to five days' duration.

Roentgenologic Examination. A severely distended, smoothly bordered intestinal loop arose out of the pelvis and extended obliquely across the mid-abdomen to the left subcostal area. There was moderate distention of other colonic segments. The diagnosis was volvulus of the sigmoid with the obstructed loop veering to the left. Contrast study of the colon revealed obstruction at the rectosigmoid junction with readily discernible torsion effects at this site.

Surgery. This patient refused surgery and left the hospital but had to be re-admitted on the succeeding day. At surgery there was a 360° clock-wise torsion of a long, redundant sigmoid loop with pronounced ecchymoses and considerable mesenteric thickening. Following detorsion the sigmoid mesentery was plicated. During the postoperative period this patient developed uremia and progressive distention of the small intestine which on January 19, 1950 led to a second operation for intestinal obstruction. A volvulus of the entire small bowel was encountered and corrected. The patient expired on January 20, 1950.

Comment. This case is representative of a rather typical appearance of sigmoid volvulus with the smoothly bordered obstructed sigmoid loop veering to the left. The contrast study demonstrated the point of obstruction and torsion effects at this site.

Case V (Fig. 5, *A*, *B* and *C*). W.G., a sixty-nine year old Negro male, was admitted on March 23, 1949 complaining of abdominal distention, nausea and pain of five days' duration. He had had a previous history of constiptation with alternating periods of diarrhea and occasional lower abdominal cramping pain.

Roentgenologic Examination. Severe distention by gas and fluid of a smoothly bordered intestinal loop arising from the pelvis and reaching the right diaphragmatic dome and considerable distention of other intestinal segments along the left flank were noted. Contrast study of the colon revealed obstruction of the

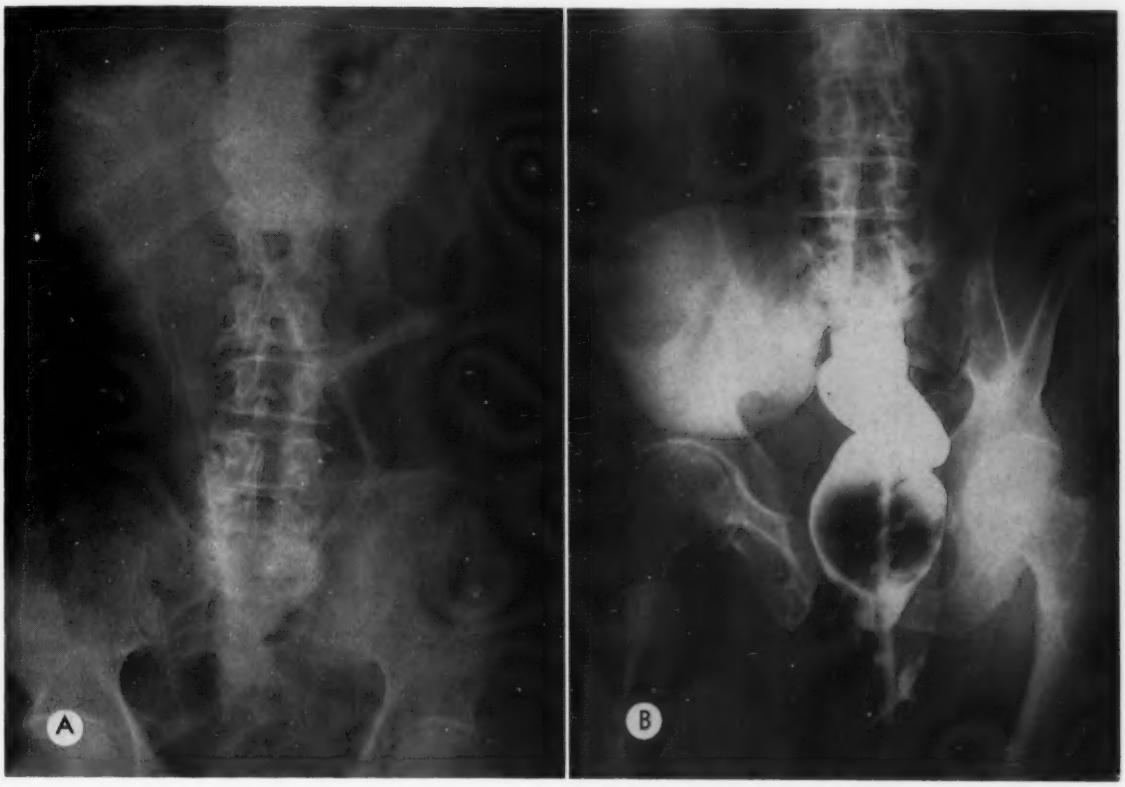

Fig. 3. Case III. (*A*) Note the sigmoid loop arising from the pelvis and deviating to the right flank with partial superimposition of the afferent and efferent components of the sigmoid. (*B*) Note the obstruction at the rectosigmoid deviation and partial filling of the sigmoid loop.

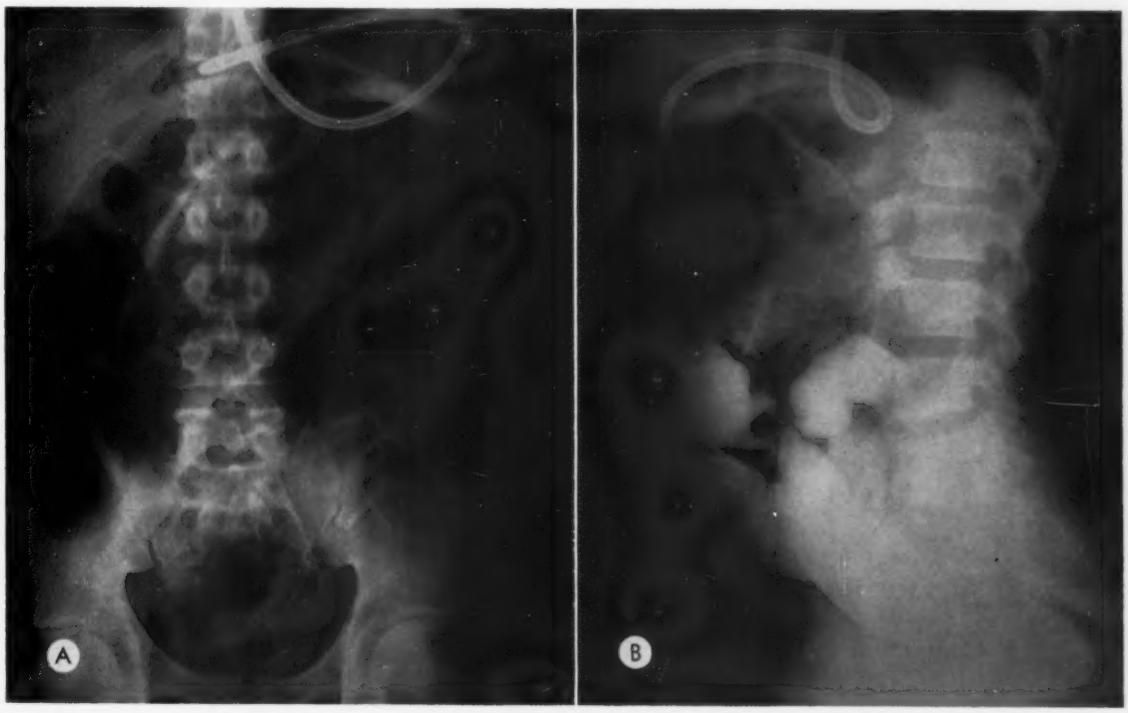

Fig. 4. Case IV. (*A*) Note the obstructed sigmoid loop high in the upper left abdomen. (*B*) Marked torsion effects are seen at the rectosigmoid junction on contrast study.

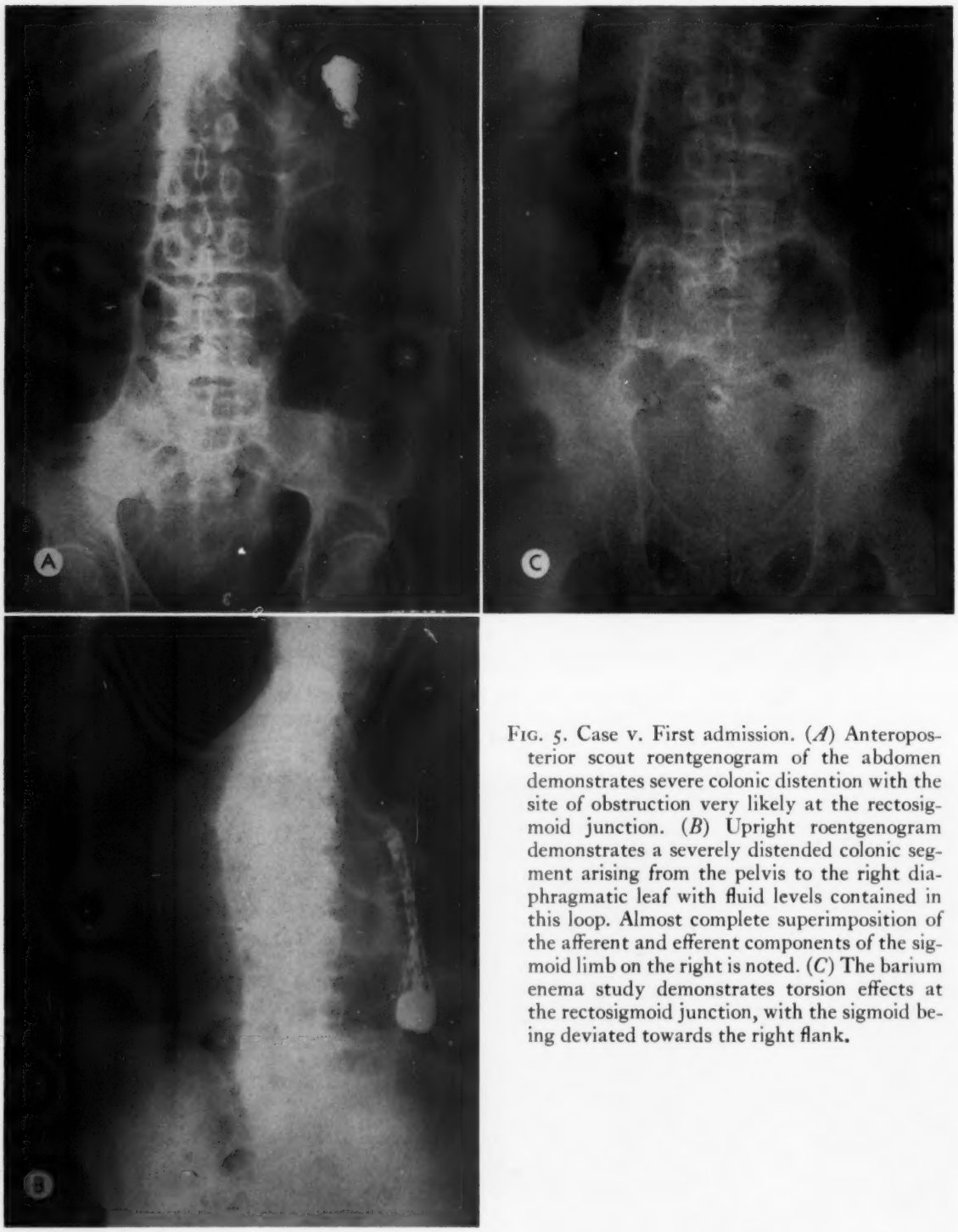

Fig. 5. Case v. First admission. (*A*) Anteroposterior scout roentgenogram of the abdomen demonstrates severe colonic distention with the site of obstruction very likely at the rectosigmoid junction. (*B*) Upright roentgenogram demonstrates a severely distended colonic segment arising from the pelvis to the right diaphragmatic leaf with fluid levels contained in this loop. Almost complete superimposition of the afferent and efferent components of the sigmoid limb on the right is noted. (*C*) The barium enema study demonstrates torsion effects at the rectosigmoid junction, with the sigmoid being deviated towards the right flank.

sigmoid at the level of the right iliac crest due to volvulus with the sigmoid loop oriented along the right flank.

Surgery. On surgical exploration a volvulus of the sigmoid with counter-clockwise rotation of 360° was corrected. Resection or plication, however, was not undertaken. Subsequent persistent abdominal distention necessitated a re-examination on April 16, 1949 when again a roentgenologic diagnosis of sigmoid volvulus

was made. On second surgical exploration a counter-clockwise torsion of the sigmoid of 180° was corrected and the mesentery of the sigmoid was plicated.

Second Admission (Fig. 6, *A* and *B*). This patient was re-admitted on March 28, 1951 with a recurrence of symptoms. At this time roentgenologic examination revealed a large, smoothly bordered, markedly distended intestinal loop arising from the pelvis and occupying most of the central portion of the abdomen surrounded by distended colonic segments. Examination by means of a barium enema revealed complete sigmoid obstruction at the level of the second sacral segment with typical torsion effects at this level. A third surgical exploration on the succeeding day confirmed the roentgenologic diagnosis of volvulus of the sigmoid. The large loop of the sigmoid was exteriorized and subsequently resected with secondary closure at a later date. He was discharged on May 5, 1951.

Comment. Note the difference of location of the sigmoid loop and the variations in the obstructive pattern on different admissions. Variations in appearance are related to relative lengths of the sigmoid loop. As a result of previous plication of the mesentery, the sigmoid loop was much shorter and broader at the time of the second admission. Such anatomic variations will, of course, explain the variability of the roentgen pattern of the obstructed sigmoid loop in cases of sigmoid volvulus.

Case vi (Fig. 7, *A*, *B* and *C*). H.E., a sixty-two year old white male, was admitted on January 14, 1951 complaining of abdominal pain of seven days' duration and constipation of four days' duration. Rectal bleeding had been noted at the onset of illness and was followed by diffuse, cramping abdominal pain, distention and vomiting.

Roentgenologic Examination. Severe distention of the entire colon, particularly of a smoothly bordered loop, paralleling the course of the descending colon was visualized. A right decubitus roentgenogram demonstrated two long fluid levels, one at the midline, the second along the left flank extending almost over the entire length of the abdomen and ap-

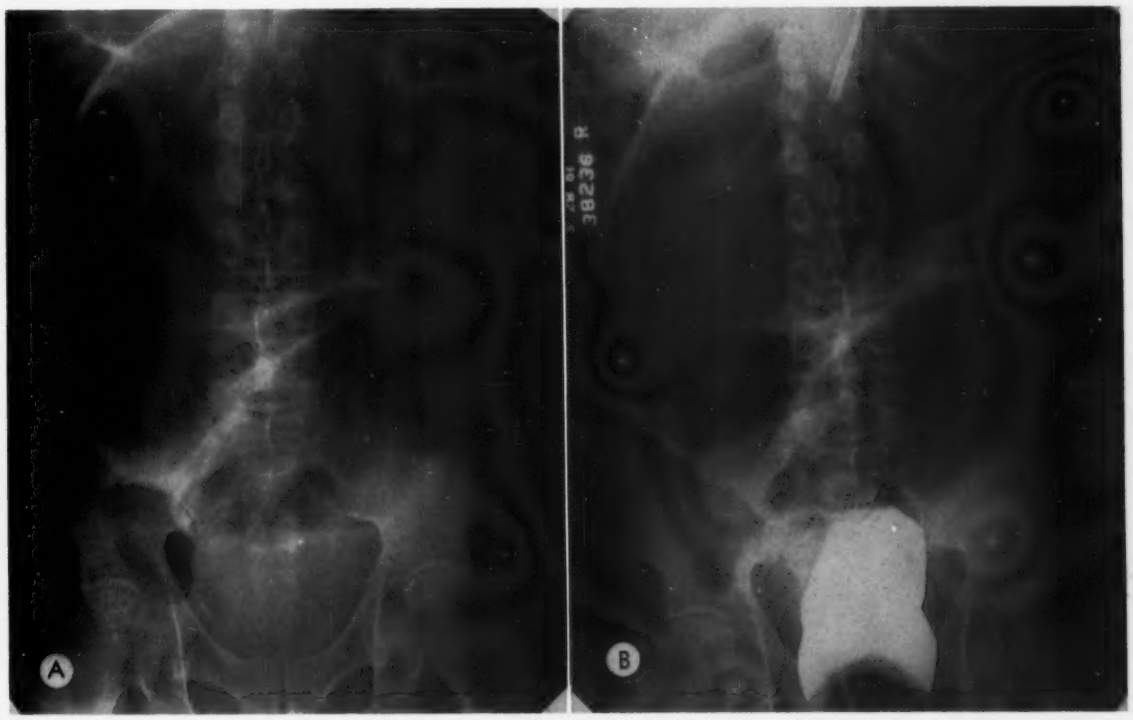

Fig. 6. Case v. Second admission. (*A*) Note the severely distended sigmoid loop which fills the entire abdomen. (*B*) The barium enema study demonstrates torsion effects at the rectosigmoid junction.

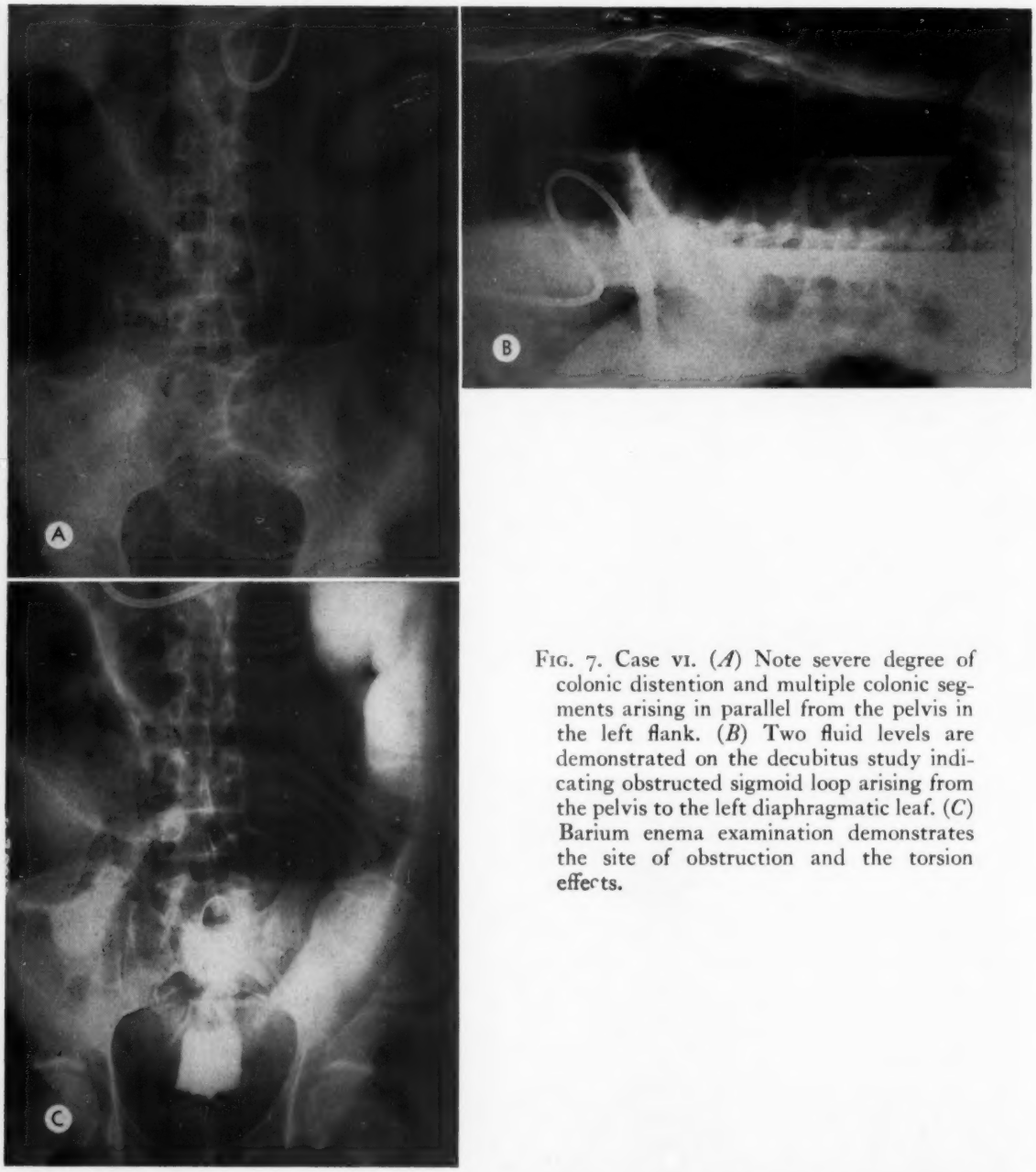

Fig. 7. Case vi. (*A*) Note severe degree of colonic distention and multiple colonic segments arising in parallel from the pelvis in the left flank. (*B*) Two fluid levels are demonstrated on the decubitus study indicating obstructed sigmoid loop arising from the pelvis to the left diaphragmatic leaf. (*C*) Barium enema examination demonstrates the site of obstruction and the torsion effects.

parently contained in the ascending and descending limbs of an obstructed loop. A contrast study of the colon revealed an obstruction at the rectosigmoid junction with torsion effects. There was a marked complicating gastric dilatation.

Surgery. On surgical exploration a detorsion of the volvulus was accomplished. There were numerous petechiae in the mesentery of the sigmoid which was plicated. The patient was discharged on January 18, 1951.

Comment. In this case a very confusing gas pattern secondary to volvulus of the sigmoid was encountered. Immediate diagnosis was established by means of a right decubitus study and contrast examination of the colon.

Case vii (Fig. 8, *A*, *B*, *C* and *D*). M.D., an eighty-four year old white male was admitted on December 6, 1955 with a history of jaundice of approximately one month's duration. Subsequent clinical and laboratory studies in-

Fig. 8. Case vii. (*A*) Note the smoothly constricted distal sigmoid and the crossing of mucosal folds due to partial torsion.

dicated a probable infectious hepatitis and this diagnosis was made at the time of discharge.

Roentgenologic Examination. Incidental roentgenologic examination of the gastrointestinal tract revealed on the barium enema study a long, smoothly narrowed segment of colon, just proximal to the rectosigmoid junction. There was smooth, conical tapering of the bowel at each extremity of this deformed segment. The sigmoid loop was moderately redundant and there was evidence of a colonic diverticulosis involving the proximal sigmoid. The fluoroscopic impression was that of a possible inflammatory narrowing of the distal sigmoid. Upon reviewing the roentgenographic films it was apparent that the mucosa was completely intact and that a crossing or spiraling of mucosal folds was present. On this basis, the possibility of physiologic volvulus was considered. On re-examination of the colon the same deformity was noted. However, as the patient's right side was elevated, the redundant sigmoid loop was seen to shift toward the patient's left side and the narrowed pathologic segment to distend in a normal fashion. As the patient assumed the supine position, the sigmoid again deviated toward his right side and the area of narrowing re-appeared.

Sigmoidoscopic Examination. Subsequent sigmoidoscopic examination confirmed the presence of an area of narrowing at the rectosigmoid junction with the bowel lumen being completely distensible. It was felt the findings were consistent with a partial volvulus at this site.

Comment. We assume this case to represent a so-called physiologic form of volvulus involving the efferent component of the sigmoid loop, just proximal to the rectosigmoid junction. This case is somewhat unusual in that a fairly long, narrowed segment was encountered. Generally, in the physiologic form of volvulus when one component of the loop is involved, a fairly localized area of narrowing is seen. This case is also interesting in that a reduction

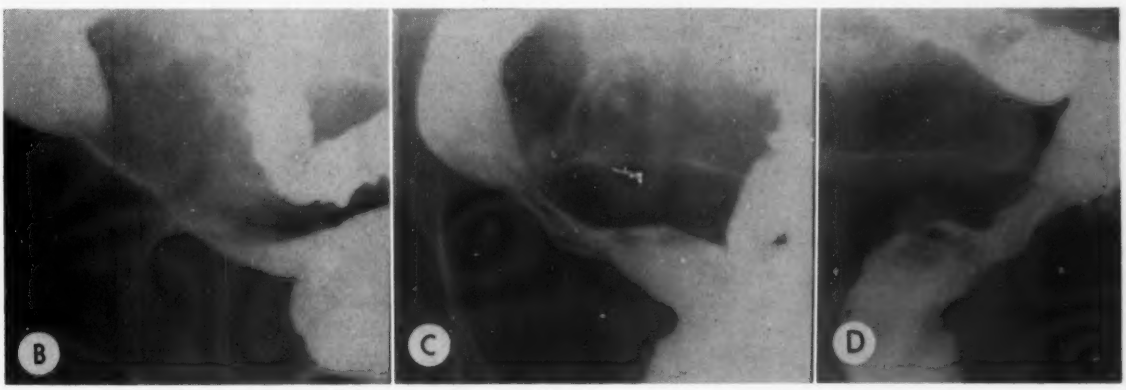

Fig. 8. Case vii. (*B*, *C* and *D*) Series of spot roentgenograms demonstrating detorsion when the patient's right side was elevated.

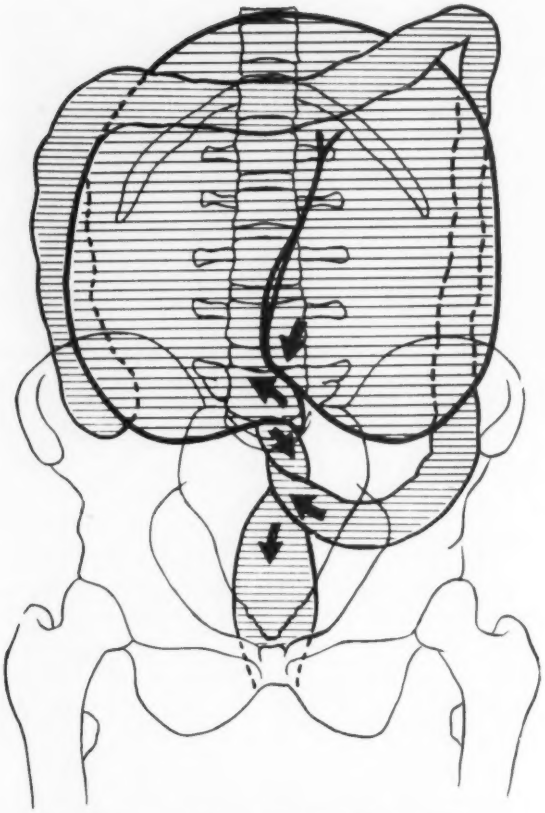

FIG. 9. Diagrammatic representation of typical mechanism in sigmoid volvulus.

of the volvulus was observed as the patient's position was changed. The partial or physiologic form of volvulus recurred when the patient assumed a supine position.

SUMMARY

A series of cases illustrating the typical and atypical roentgen patterns of obstruction due to sigmoid volvulus is presented.

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LARGE DIVERTICULUM OF THE RECTUM

REPORT OF A CASE

By OWEN W. DOYLE, M.D.
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DIVERTICULA of the colon are very common and have been reported in 9 per cent of roentgenographic examinations of the colon and in 10 per cent of routine necropsies. Diverticulum of the rectum, however, is rare. In 1929, Spriggs and Marxner[4] reported 3 cases in the rectum in a review of 100 cases of diverticulosis of the colon. In 1936, Willard and Bockus[5] reported 1 case in the rectum out of 72 cases of diverticulosis of the colon. In 1948, Goodwin and Collins[2] reviewed 726 cases of diverticulosis of the colon, none of which was in the rectum. In the cases mentioned above the size of the rectal diverticula observed was not given. In 1953, Mayo[3] reviewed the cases of diverticulosis of the colon at the Mayo Clinic. He reported that the proctologist had never seen a diverticulum lower than 12 cm. above the anus. The roentgenologist reported that a diagnosis of diverticulum had not been made by roentgen examination at that time. The pathologist had not seen a diverticulum below the peritoneal reflection either in a resected rectum or at necropsy.

The cause of true diverticulum, where all coats of the bowel are represented, is thought to be congenital. The more common false diverticulum consists of mucosa and serosa, the former having herniated through the muscular coat of the bowel. The diverticulum seen most commonly in the sigmoid colon is of the acquired or false type. There are several factors which contribute to the formation of false diverticula. Excessive pressure on a hereditary or acquired weak colonic musculature results in the pouch-like protrusions of the mucous membrane between the muscle fibers. Obesity may be a cause of acquired colonic muscular weakness. It is possible that infiltration of fat into the intestinal musculature could create areas of weakness for potential diverticulum formation.

The average size of colon diverticula is 8 mm. in diameter.

FIG. 1. Spot roentgenogram showing a 7 cm. diverticulum projecting off the left margin of the rectum.

FIG. 2. Spot roentgenogram in right oblique view showing the neck of the diverticulum.

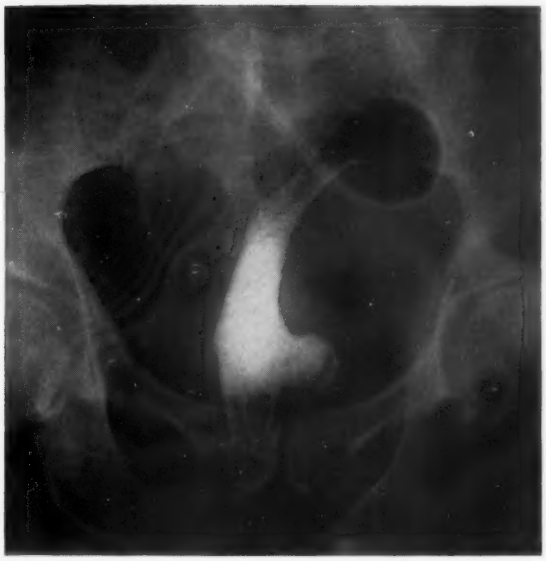

Fig. 3. Partial evacuation roentgenogram showing contraction of the diverticulum.

The following case report involved a diverticulum of the rectum which measured 7 cm. in diameter.

REPORT OF A CASE

An eighty-six year old white male had increasing constipation for a period of three years. He had no previous illness or surgery. Barium enema examination revealed a large 7 cm. diverticulum projecting off the left margin of the rectal ampulla (Fig. 1 and 2). The diverticulum emptied partially on evacuation of the barium enema (Fig. 3). No defects were noted in the mucosa and no other abnormality was demonstrated at the time of proctoscopy.

SUMMARY

A case of a large diverticulum of the rectum is reported. Although there is no histologic proof that this diverticulum is of the congenital type, its contraction after the barium enema evacuation suggests that it is a true diverticulum containing muscular fibers.

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BOWEL PREPARATION FOR ROENTGENOLOGIC PROCEDURES USING A NEW EVACUANT, BISACODYL*

By M. H. POPPEL, M.D., *and* C. K. BANGAPPA, M.D.
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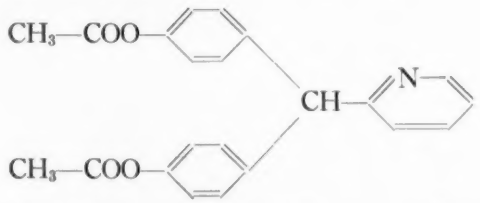
GOOD preparation is essential for the proper roentgenologic examination of the gastrointestinal tract, the biliary tract, the urinary tract, the spine, and other abdominal structures. The need for repeat examinations is minimized in well prepared patients, and fewer roentgenographic exposures are required in the absence of confusing shadows caused by gas and feces. The preparation of patients for barium enema study and gastrointestinal series should leave the alimentary tract free of significant irritability so that the mucosa may be properly visualized without the occurrence of functional abnormalities.

The usual preparation for a barium enema study involves either stiff purgation or multiple cleansing enemas, which are regarded by most patients as unpleasant. Furthermore, these procedures are frequently irritating to the colon and do not always assure adequate cleansing for roentgenologic purposes. An analysis of preparative procedures for barium enema examinations in a large municipal hospital showed failure rates of 18 per cent in outpatients and 15 per cent in inpatients when castor oil was used, with rates of 20 per cent and 40 per cent, respectively, when cleansing enemas were used. Accordingly, alternative methods of preparation have been sought that would eliminate or minimize unpleasant procedures, so that patients might be free of fear and apprehension at the time of examination.

This study was undertaken to determine whether bisacodyl,* a new agent differing from other laxatives in its method of action, could be used routinely in the preparation of patients for barium enema and other roentgenologic examinations of the abdomen. Chemically, bisacodyl is a pyridylmethane derivative with the following structural formula:



Administered either orally or rectally, it promotes normal peristaltic movements throughout the colon. Its action depends on local contact with colonic mucosa, rather than on systemic absorption.[6] For this reason, evacuation usually occurs eight to ten hours after oral administration; and within one hour (often within fifteen to twenty minutes) after rectal administration. Evidence from various experiments indicates that bisacodyl acts neurogenically by selective stimulation of the parasympathetic nerves of the colon.[3,7,8]

The toxicity of bisacodyl is negligible for practical purposes, since it has a therapeutic ratio of 1:200.[8] Serious reactions to the drug have never been observed, and there are apparently no contraindications to its use, other than an acute surgical abdomen.

Bisacodyl has been employed most extensively to promote normal evacuation in bedridden patients,[1,9,10] but several reports[2,4,5] indicate that it may be used with advantage to prepare patients for roentgenologic examination. These reports emphasize that the preparation is convenient and acceptable both to patients and to the nursing staff, and that the colon is free of feces and gas at the time of examination.

MATERIALS AND METHODS

In 249 unselected adult patients referred for various types of roentgenologic exami-

* Dulcolax(TM)—Geigy.

* From the Department of Radiology of the New York University-Bellevue Medical Center, New York, New York.

Table I

BOWEL PREPARATION FOR BARIUM ENEMA STUDY, BISACODYL ADMINISTERED ORALLY AND RECTALLY

Dosage	No. of Patients	Evaluation					
		Satisfactory		Fair		Poor	
		No.	Per Cent	No.	Per Cent	No.	Per Cent
10 mg. plus suppository	8	2	25.0	5	62.5	1	12.5
15 mg. plus suppository	48	36	75.0	11	22.9	1	2.1

nation of the abdominal region, the administration of bisacodyl served as the only preparative procedure for cleansing the gastrointestinal tract. In general, these patients were not troubled with constipation or diarrhea. Evacuation was considered normal in 234 of the 249 patients. Doses of 10 or 15 mg. of bisacodyl were administered orally in enteric-coated tablets on the evening before the examination, and an additional booster dose of 10 mg. was administered by rectal suppository on the morning of the examination of those patients who were to be given a barium enema.

RESULTS

The effectiveness of this method of bowel preparation for barium enema examination is summarized in Table 1, and its effectiveness in other procedures in Table II. The results were evaluated according to the ease with which significant areas were visualized, taking into account the presence of gas or fecal shadows.

In general, better results were obtained when the higher of the two oral dosage levels of bisacodyl was employed, especially among the 56 barium enema patients who received booster doses of bisacodyl by rectum. The failure rate was 12.5 per cent in 8 such patients on an oral dose of 10 mg., and dropped to 2.5 per cent in 48 patients on an oral dose of 15 mg. Among 193 patients who were given oral doses of 10 or 15 mg. without a suppository booster, the failure rate was 6.2 per cent. Particularly good results

Table II

BOWEL PREPARATION FOR VARIOUS PROCEDURES, BISACODYL ADMINISTERED ORALLY

Procedure and Dosage	No. of Patients	Evaluation					
		Satisfactory		Fair		Poor	
		No.	Per Cent	No.	Per Cent	No.	Per Cent
Gastrointestinal series							
10 mg.	84	51	60.7	29	34.5	4	4.8
15 mg.	40	31	77.5	8	20.0	1	2.5
Scout roentgenogram of abdomen							
10 mg.	35	25	71.4	8	22.9	2	5.7
15 mg.	7	5	71.4	2	28.6	0	0.0
Spine, pelvis, bladder, gallbladder							
10 mg.	16	10	62.5	4	25.0	2	12.5
15 mg.	11	4	36.3	4	36.4	3	27.2
Totals							
10 mg.	135	86	63.7	41	30.4	8	5.9
15 mg.	58	40	69.0	14	24.1	4	6.9

were achieved in examinations of the upper gastrointestinal tract, and in procedures involving scout roentgenograms of the abdomen. Gas shadows were absent or minimal in 87.5 per cent of the patients, and fecal shadows were almost never observed in any of the patients prepared with bisacodyl.

The response of patients to orally administered bisacodyl occurred reliably within four to eleven hours after administration. Evacuation occurred after eight hours on the average in 143 patients on a dose of 10 mg., and after six and one half hours in 106 patients on a dose of 15 mg. Only 3 patients failed to respond to these dosages. Suppositories containing 10 mg. of bisacodyl produced bowel movements within five to thirty minutes in 49 of 56 patients, and the lack of response in the rest was usually attributed to an empty colon.

Side effects were infrequent in this group of 249 patients given bisacodyl. Transient abdominal cramps were reported by 25 patients (10 per cent), but were never severe. Two patients experienced nausea and vertigo (0.8 per cent). Irritation of the colon was observed at fluoroscopy in one patient (0.4 per cent).

COMMENT

Preparation of patients for roentgenologic examination by means of this new evacuant results in a more reliable cleansing effect than is obtained from castor oil or cleansing enemas. Bisacodyl is simple to administer, and directions for its use are easily understood. It is readily accepted by patients, and need not disturb sleep if taken before retiring. Because it is gentle and nontoxic, it may be given to children and to the aged, to pregnant and nursing women, and to debilitated patients. It may be used in the presence of complicating disorders such as cardiovascular, renal, and hepatic disease. From the viewpoint of the nursing staff it saves time and obviates the need for unpleasant cleansing enemas, which are often difficult to accomplish in outpatients. The administration of 15 mg. of bisacodyl orally on the evening before examination is recommended as adequate for the preparation of patients for many types of abdominal roentgenologic examination. An additional 10 mg. administered rectally on the morning of examination can be relied on in almost all cases to complete the cleansing of the colon, and should result in satisfactory visualization even in procedures presenting as much difficulty in preparation as pyelography. The additional suppository is mandatory in barium enema examinations to insure complete emptying of the entire colon, including the cecum, and should be routinely considered in all patients with a history of constipation.

SUMMARY

1. Bisacodyl, a new evacuant, was used to prepare 249 patients for roentgenologic examination of the abdominal region.

2. Administered orally, it produced a satisfactory cleansing effect for a variety of roentgenologic procedures. In preparing patients for barium enema study, an additional rectal suppository permitted a satisfactory examination without the use of any other cleansing procedure.

3. The agent is nontoxic and rarely causes any discomfort to patients. It eliminates the need for difficult and unpleasant procedures, such as stiff purgation and cleansing enemas.

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Bisacodyl for this study was supplied as Dulcolax(TM) tablets and suppositories by Geigy Pharmaceuticals, Ardsley, New York.

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EDITORIALS

OUR CHANGING CONCEPTS OF THE ROENTGEN EXAMINATION OF THE COLON

EXAMINATION of the colon by various contrast media has constituted a fertile field of investigation since the inception of clinical roentgenology more than fifty years ago. For a short time, orally administered bismuth was used for opacification; then, the recognition of barium sulfate as a physiologically inert substance at once transformed roentgen examination of the colon, particularly in the form of the enema study, into a major clinical procedure with many possibilities. The medical literature since then is replete with detailed information of the varied methods employed and of the numerous modifications or innovations which are continually being made with the development of steady technical improvements. Recent examples of excellent contributions to this subject are those of Robinson,[1] Welin,[2] Figiel *et al.*[3] Stevenson,[4] and others.

In the early twenties the roentgen examination of the colon was rather crude, often consisting of roentgenograms of the abdomen in a single projection following barium enema administration, the colon usually being filled and distended by the very dense barium. Diverticula and grossly constricting or obstructing neoplasms could be demonstrated in this manner. By 1930, Weber[5] had developed the American version of the double contrast barium enema method, which in his hands could be used to detect much smaller and perhaps asymptomatic lesions. More widespread acceptance of this procedure did not occur, however, until the past decade, when better fluoroscopic screens and spot film devices became available. As the incidence of polypoid mucosal lesions became better appreciated and as these lesions began appearing at the fluoroscopic examination, better methods for visualizing them were sought. In 1953, Moreton[6] advocated the double contrast study as a primary routine procedure. Today many proctologists, internists, and surgeons request the double contrast study as the initial colon examination.

Other methods have been developed in an attempt to make the barium mixture semitransparent. In the thirties this was done through the use of a very dilute medium or by overexposing films. Gianturco[7] advocated the high kilovoltage technique as early as 1936, but its full value could not be appreciated until the late forties, when roentgen tube design and engineering advance made possible general use of voltages in the range of 120 kv. with high milliamperage. Robinson[1] and others have combined the high kilovoltage technique with routine medium kilovoltage spot roentgenography of the sigmoid and descending segment of the colon. Figiel and co-workers[3] have further modified this method by taking large field high kilovoltage spot compression roentgenograms of all flexures and any abnormal segment as a routine procedure. Others are now evaluating the use

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[6] MORETON, R. D. Double-contrast examination of the colon with special emphasis on studies of sigmoid. *Radiology*, 1953, *60*, 510–517.

of electronic fluoroscopic image amplification as an adjunct to routine fluoroscopy.

Innumerable references in the literature are made to the adequate preparation of the bowel prior to the barium enema examination. A nonresidue diet, castor oil catharsis, and several cleansing enemas are almost universally agreed to be necessities. The use of tannic acid in both the preparatory enema and the contrast enema is advocated by many to reduce mucous secretion and stimulate good evacuation. Investigators in the past have relied on good postevacuation roentgenograms to exclude polyps larger than 1 cm. in diameter, but at the present, using newer procedures, polyps only a few millimeters in size are being detected.

It is now a well established fact that there is a significant incidence of colonic polyps in the general adult population. Gianturco[7] states that a coordinated program in a diagnostic center should lead to the discovery of polyps in 10 to 15 per cent of adult patients regardless of symptoms. Welin[2] was able to demonstrate polypoid tumors in 11 per cent of 7,561 patients by using the double contrast technique. This corresponded remarkably with the autopsy incidence of 11.3 per cent colonic polyps found in his institution. Of the cases operated upon almost half were termed cancerous or precancerous. Figiel and co-workers[3] cite Hultborn who found one or more polyps in at least 50 per cent of autopsied patients over sixty years of age. The incidence of malignant change would naturally be much lower in such a group of patients. In the series reported by Figiel *et al.*,[3] the incidence of malignancy was less than 0.2 per cent in polyps under 0.5 cm. in diameter. Although it may be surgically impracticable to remove polyps above the rectum which are less than 0.5 cm. in diameter despite their predisposition to malignancy, it nevertheless is important to know of their presence. They should be watched as closely for malignant change with periodic examinations as one would watch a mole or keratosis on the skin. One needs only to be reminded that about 17 per cent of all cancer deaths in the United States are due to carcinoma of the colon and rectum.

The controversy with respect to the relative merits of the double contrast enema technique and the high kilovoltage spot pressure roentgenographic methods has not yet been settled. In this country the tendency is to relegate the double contrast enema study to a confirmatory role in carefully selected cases. It is difficult, however, to refute the excellent technique and equally impressive statistics compiled by British authors, using air contrast methods routinely. Their results are undoubtedly improved by the meticulous preparation of the bowel performed in the department of radiology. Technical adjuncts such as the controlled barium siphonage for rectal evacuation, the use of compressed carbon dioxide replacing air injection, the employment of highly refined barium of smaller particle size, the application of elaborate mechanical injection methods, and the practice of obtaining roentgenograms in many different projections are additional important factors which contribute greatly to increasing the accuracy of the roentgen examination of the colon.

The radiologist is rare indeed who, at some time, has not rendered a negative roentgenologic report, and has been shortly thereafter chagrined to have a cancer of the colon found in his patient. Ramsay[8] recently described a series in which a negative report was given in 16.7 per cent of 54 patients with carcinoma of the sigmoid. In these patients a marked delay in diagnosis occurred. Such discouraging results should constitute a warning to the radiologist that

[7] Gianturco, C. High voltage technic in diagnosis of polypoid growths of the colon. *Radiology*, 1950, *55*, 27–29.

[8] Ramsay, G. S. The negative x-ray report in cancer of the colon. *Brit. J. Surg.*, 1956, *43*, 576–579.

he is obligated to use all available methods to enhance the thoroughness and reliability of his examination.

Radiologists as clinical investigators must of necessity keep abreast of new concepts and procedures. Hodges[9] states that "the competence and diligence of the examiner are vastly more important than the precise nature of the techniques he employs." Conversely, it would seem that competence and diligence would be lacking if the very best techniques and equipment were not employed.

Arch H. Hall, M.D.

[9] Hodges, P. C. Roentgen examination of the colon. *J.A.M.A.*, 1953, *153*, 1417–1421.

WARREN W. FUREY, M.D.
1898–1958

NOT only Radiology but American medicine suffered a great loss with the passing of Dr. Warren William Furey, who died peacefully in his sleep on November 19 while attending the annual meeting of the Radiological Society of North America at the Palmer House, Chicago, Illinois.

Dr. Furey was a Chicagoan, from birth and through life, born January 8, 1898 in the now famous tough "First Ward" that has contributed many of Chicago's distinguished individuals. After receiving his elementary and high school education at St. James School, he obtained his premedical education at the University of Illinois and his medical degree from Northwestern University in 1923. Following an internship at Mercy Hospital and a short

period of private practice on the West Coast, Dr. Furey returned to Mercy Hospital as Clinical Assistant in Orthopedic Surgery and in 1930 transferred to roentgenology as Clinical Assistant until 1933. He was certified by the American Board of Radiology in 1934. He was appointed radiologist to the Little Company of Mary Hospital in 1931, a position he held at the time of his death. In 1944 he returned to Mercy Hospital as Director of the Department of Radiology, was appointed Assistant Professor of Radiology in the Stritch School of Medicine, Loyola University and as Clinical Professor of Radiology in 1954. Dr. Furey at one time served on the teaching staff of Northwestern University Medical School, his alma mater. He also had an active private practice of Radiology with an office in the Loop.

Dr. Furey was honored with many positions of leadership within medicine. Indeed, his was a life replete with activity and achievement. He had just been elected to the Board of Trustees of the American Medical Association, had been an outstanding delegate to the House of Delegates from the Illinois Medical Society for several years and had served on important committees. Always intensely interested in local medical activities, he was President of the Chicago Medical Society; Secretary, Vice-President and President of the Chicago Roentgen Society; a member of the Board of Directors, Treasurer and President of the Illinois Medical Service (Blue Shield) and President of the Tuberculosis Institute of Chicago and Cook County. His interest in the socio-economics of medicine was reflected by his posts of leadership in the National Blue Shield Commission which he served as Secretary and as a member of the Executive Committee.

The many positions of leadership held by Dr. Furey in organized radiology are well known by the readers of this JOURNAL. He served on the Executive Council of the American Roentgen Ray Society in 1948. He was a Director, President and Gold Medal recipient of the Radiological Society of North America; Treasurer, Chancellor and President of the American College of Radiology. For his outstanding contributions, the Gold Medal of the American College of Radiology was bestowed posthumously upon him at the annual meeting in February, 1959. He was also a member of the American Radium Society, the International College of Surgeons, the Inter-American College of Radiology and the Institute of Medicine in Chicago.

Many honors and citations came to Dr. Furey at an accelerated rate. In 1955 he received the Alumni Merit Medal of Loyola University and the following year an alumni citation from Northwestern University. Also from Northwestern he was presented with the alumnus award of Alpha Omega Alpha, an honor which had eluded him by a narrow margin in his medical school days. Shortly before his death he was honored with a citation from the Tuberculosis Institute of Chicago and Cook County.

Dr. Furey was a prominent Catholic layman. He was elevated to the rank of Knight of St. Gregory by the late Pope Pius XII. To his church and to his religion he gave as unstintingly of himself as he did to his profession. All who knew him admired his warm friendliness, his cheerful smile and chuckle, his realistic approach to problems confronting Radiology and medicine and his equanimity. Those of us who attended the funeral services will long remember the tribute paid to him from which this quotation is taken, "His faith made the man; a man who from humble beginnings rose to a position of preeminence in his field and yet remained a humble man."

Surviving the death of Dr. Warren W. Furey are his beloved and devoted wife, Veronica; two sons, Warren, Jr., a medical student at Northwestern and Edward; and two daughters, Rosemary and Mrs. Virginia Lawler. His many friends throughout the Country join with his family in mourning the passing of our dear friend and faithful colleague who gave so much, so often and so freely.

EARL E. BARTH, M.D.

CHESTER A. STAYTON, SR., M.D.
1889–1958

CHESTER A. STAYTON, SR., M.D. died October 8, 1958, after a short illness. He was born in Centerton, Indiana, April 29, 1889. He received his B.A. degree at Indiana University in 1913 and his M.D. degree in 1915. He served his internship in the Indianapolis General Hospital.

Dr. Stayton was a Captain in the Army Medical Corps in 1917 and served through 1919, after which time he joined the U. S. Public Health Service. He continued with the Public Health Service until 1925 serving in Cincinnati and Indianapolis. He began the private practice of Radiology in

Indianapolis in 1925 continuing until his death.

He was Assistant Professor of Radiology at Indiana University Medical School. He was Director of Region 4 of the American Cancer Society and a Past Vice-President of the Society's Indiana Division. He was a Fellow of the American College of Radiology; Past President of the Indiana Roentgen Society; a diplomate of the American Board of Radiology; and member of the Radiological Society of North America, Indiana State Medical Society, Indianapolis Medical Society, American Medical Association and the American Radium Society.

Dr. Stayton was a member of St. Paul's Episcopal Church, Mystic Tie Lodge, American Legion and the Kiwanis Club. In addition, he was Chairman of the Department of Radiology at St. Francis and Witham (Lebanon) Hospitals. He was founder and former editor of the Indianapolis Medical Society Bulletin and a member of the Phi Beta Pi medical fraternity.

Surviving are the widow, Marion D. Stayton, a son Chester, Jr., and two daughters, Mrs. J. C. Katterjohn and Mrs. John C. Dittrich. Three sisters also survive and eleven grandchildren.

Both Dr. Stayton's son, Chester, and his son-in-law, Dr. James C. Katterjohn, are radiologists and were associated with him in his practice.

He had a warm friendly personality which won him a host of friends. His loss will be felt most acutely by all of us who knew and admired him.

Raymond C. Beeler, M.D.

SOCIETY PROCEEDINGS AND NEWS ITEMS

GOLD MEDALS AWARDED BY THE AMERICAN COLLEGE OF RADIOLOGY

At the Convocation ceremonies of the Annual Meeting of the American College of Radiology held at the Drake Hotel in Chicago, Illinois on February 6, 1959, four Gold Medals, the highest award of the College, were presented by Dr. Vincent W. Archer of Charlottesville, Virginia, President, assisted by Dr. Earl E. Barth of Chicago, Illinois, Chairman of the Board of Chancellors.

Dr. Robert S. Stone, *center*, is presented the Gold Medal of the College by Dr. Vincent W. Archer, *right*, assisted by Dr. Earl E. Barth, *left*.

Dr. Robert S. Stone, Professor and Head of the Department of Radiology, University of California School of Medicine, San Francisco, California, and Dr. Leroy Sante, Professor and Director of the Department of Radiology at St. Louis University Medical School and St. Mary's Hospital Group, St. Louis, Missouri, were honored for their many contributions to the College "and the profession for which it stands."

Dr. Warren W. Furey of Chicago and Dr. C. Edgar Virden of Kansas City were honored posthumously. The Gold Medal of Dr. Furey was received for his late father by Warren W. Furey, III, a third year student of Northwestern University School of Medicine, Chicago, Illinois.

Dr. LeRoy Sante, *center*, receives the Gold Medal of the American College of Radiology.

Warren W. Furey, III, *center*, receives for his late father, Dr. Warren W. Furey, the posthumous Gold Medal award from the American College of Radiology.

OFFICERS OF THE AMERICAN COLLEGE OF RADIOLOGY

At the Annual Meeting of the American College of Radiology, held at the Drake Hotel in Chicago on February 6, 1959, the following officers were elected: President, Dr. Lawrence Reynolds, Harper Hospital, Detroit, Michigan; Vice President, Dr. Charles M. Gray, Tampa, Florida; Secre-

tary-Treasurer, Dr. Fay H. Squire, Chicago, Illinois, (re-elected); Chairman, Board of Chancellors, Dr. Earl E. Barth, Chicago, Illinois, (re-elected).

The Executive Director of the American College of Radiology is William C. Stronach, 20 North Wacker Drive, Chicago 6, Illinois, and the Director of Public Relations is Hugh M. Jones, Chicago, Illinois.

The two new Chancellors elected for four year terms are Dr. Ralph M. Caulk, Washington, D. C., and Dr. Theodore J. Wachowski, Wheaton, Illinois.

The next Annual Meeting will be held February 3–6, 1960 at the Roosevelt Hotel in New Orleans, Louisianna.

COURSE IN CLINICAL USE OF RADIOACTIVE ISOTOPES

A course in the clinical use of radioactive isotopes will be given under the supervision of Dr. Sergei Feitelberg and Dr. Edith Quimby, of the Department of Radiology, Columbia University, New York City, from June 1 through June 27, 1959. This is a full-time course which includes lectures, experimental laboratory exercises, clinical rounds, and clinical measurements on patients and on specimens. In addition to Professors Feitelberg and Quimby, the teaching staff includes sixteen invited lecturers from the New York area, each presenting material in his own special field.

Lectures. Topics include physics of radioactive isotopes, interaction of radiation and matter, and techniques of measurement of radiation and of radioactive isotopes. Clinical uses of radioactive iodine, phosphorus, and gold will be presented in detail; special lectures will cover miscellaneous diagnostic studies with radioactive iron, sodium, chromium, and other elements. Organization of isotope work in a hospital will be developed from a practical point of view.

Laboratory Work. Thirteen afternoons are devoted to experiments on basic methods of radioisotope measurements, techniques used in clinical studies, and experience with actual clinical procedures.

Enrollment in the class is limited to 20; the fee is $300.00.

Inquiries should be addressed to Dr. Sergei Feitelberg, Mt. Sinai Hospital, Fifth Avenue at 100th Street, New York, New York.

COURSE IN RADIOLOGY AND PATHOLOGY OF SKELETAL SYSTEM, UNIVERSITY OF WISCONSIN

The Departments of Radiology and Pathology of the University of Wisconsin Medical School will present a correlated two and one-half day course on the radiology and pathology of the skeletal system on May 21–23, 1959. Participating in the program will be members of the faculty of the Medical School and invited guest speakers. Among the latter will be Dr. Louis Lichtenstein, Los Angeles, California, Dr. H. J. Spjut, St. Louis, Missouri, Dr. E. B. D. Neuhauser, Boston, Massachusetts, and Dr. David G. Pugh, Rochester, Minnesota. The course will consist of lectures, panel discussions and round table conferences. It will be held in the new Continuation Center building of the University of Wisconsin under the direction of Drs. D. Murray Angevine and Lester W. Paul. Information concerning the program, course fees, lodging and other facilities may be obtained by writing to Robert C. Parkin, M.D., Coordinator of Postgraduate Medical Education, University of Wisconsin Medical School, Madison 6, Wisconsin.

COURSE IN SPECIAL RADIATION PROCEDURES IN THE TREATMENT OF CANCER

A one week intensive course in the use of specialized radiation techniques in the treatment of malignant disease will commence at the Queens Hospital Center, Monday, September 14, 1959. Enrollment in the course will be limited. The tuition will be $150.00. For additional information, apply to Dr. Philip J. Kahan, Supervising Medical Superintendent, Queens Hospital Center, 82-68 164th Street, Jamaica 32, New York.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

Diseases of the Esophagus. By J. Terracol, Professor of the Faculty of Medicine of Montpellier, France; and Richard H. Sweet, Associate Clinical Professor of Surgery, Harvard Medical School. Cloth. Price, $20.00. Pp. 682, with 409 illustrations. W. B. Saunders Company, 218 West Washington Square, Philadelphia 5, Pennsylvania, 1958.

This is an interesting book, probably the first of its kind, devoted entirely to the esophagus. It represents a laudable effort on the part of Professor J. Terracol, of the Faculty of Medicine of Montpellier, France, a noted endoscopist, whose second edition has been translated from French, with some editing, by Dr. Richard H. Sweet, Associate Clinical Professor of Surgery at Harvard University. Dr. Terracol's book enjoys a great reputation in Europe in general, and in France in particular. Dr. Sweet, in editing this book, has introduced modern surgical techniques and considerations, thus enlarging it and stressing the surgical point of view. The book presents the results of a wealth of experience of an outstanding endoscopist and an eminent surgeon working and teaching over 3,000 miles apart.

There are twenty-nine chapters in the book, with full coverage of the anatomic, histologic, physiologic, roentgenologic and esophagoscopic aspects. Special chapters deal with surgical techniques and a variety of operations; foreign bodies and their removal; and malignant diseases and their treatment by surgery as well as by irradiation.

Increased interest in the esophagus has arisen because of improved techniques in diagnosis by means of esophagoscopy and roentgenology, and because of better facilities of treatment through advances in surgery, anesthesia, the introduction of antibiotics and modern supervoltage and cobalt radiation therapy.

Each chapter is well written, detailing *in extenso* the subject under consideration. Chapter 3, on the roentgen examination of the normal esophagus, and Chapter 29, on radiation therapy of carcinoma of the esophagus, are most enlightening. The radiologist, however, will be amply rewarded, not only by reading these two chapters, but by referring freely to the other chapters as well.

There are 409 figures, drawings, tables, charts and reproductions of roentgenograms.

There is an appendix on tube feeding and special diets in esophageal conditions.

An extensive bibliography accompanies the text. This is conveniently arranged at the end of the book, with listings subdivided according to the various chapters.

The book constitutes a major contribution and is an indispensable addition to the library of interested physicians, especially the surgeon, radiologist, endoscopist and the gastroenterologist. It represents a successful and rewarding joint international scientific effort.

William H. Shehadi, M.D.

The Year Book of Radiology (1958–1959 Year Book Series). Radiologic Diagnosis edited by John Floyd Holt, M.D., Professor, Department of Radiology, University of Michigan; and Fred Jenner Hodges, M.D., Professor and Chairman, Department of Radiology, University of Michigan; Radiation Therapy edited by Harold W. Jacox, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Chief, Radiation Therapy Division, Radiologic Service, Presbyterian Hospital, New York City; and Morton M. Kligerman, M.D., Professor of Radiology and Chairman of the Department of Radiology, Yale University School of Medicine; Director of Radiology, Grace-New Haven Community Hospital. Cloth. Price, $10.00. Pp. 448, with 336 illustrations. The Year Book Publishers, Inc., 200 East Illinois Street, Chicago, Illinois, 1958.

It is again a privilege to add to our medical library the latest in the annual Year Book of Radiology series. The authors have collected and reviewed the most significant recent articles of radiologic interest from the world medical literature. These are adequately illustrated with tables, diagrams, and roentgenographic reproductions where appropriate. Sage editorial comments and explanations are included in the

usual manner. Those familiar with past volumes know that this text is valuable to the busy radiologist. Articles are condensed with sufficient detail so that one seldom needs to refer to the original journal.

The same balance between diagnostic and therapeutic radiology is maintained as in previous years. Extremely rapid developments are occurring in the diagnostic field, many of which are associated with advancing technology. Xeroroentgenography, Dynapulse timing, and solid state image amplification are but a few of the technical subjects reviewed. The section on radiobiology has been increased this year, and there are more articles on physics, dosimetry and treatment techniques. It is stated that perhaps the lack of significant improvement in the results of treatment, despite large strides in techniques and equipment, has made the editors and others in the United States and abroad more hopeful of augmenting radiation effects by using drugs, chemicals, or other means as a key to future practical applications.

ARCH H. HALL, M.D

A SYNOPSIS OF SURGICAL ANATOMY. By Alexander Lee McGregor, M.Ch. (Edin.), F.R.C.S. (Eng.), Consulting Surgeon, Johannesburg General Hospital; Honorary Research Associate, University of the Witwatersrand. Eighth edition. Cloth. Price, $7.00. Pp. 808, with 766 illustrations. The Williams & Wilkins Company, Mount Royal and Guilford Avenues, Baltimore 2, Maryland, 1957.

The fact that McGregor's "Synopsis of Surgical Anatomy" now appears in its eighth edition testifies to its popularity. For more than twenty-five years this book has been a favorite of surgeons and others who are surgically inclined; but it should also be of value to the diagnostically or therapeutically oriented radiologist who is interested in the anatomic foundation and background of his field. The radiologist will give particular attention to the original and successful presentation of the anatomy of the breast, the intestines and peritoneum including peritoneal bands, the biliary passages, the kidneys, the vertebral column, the anatomy of the child, the blood supply of bones, and epiphyseal ossification. Particularly well covered and of importance to radiologists is the exposition of lymphatic drainage of various regions and organs of the body.

The second part of the book deals with the anatomy of the abnormal in which we find a discussion of spina bifida, the azygos lobes of the lung, and the congenital abnormalities of the gastrointestinal tract and the urinary system. Diverticula of various locations are covered in a separate chapter, as are the sphincters of the digestive and urinary systems. The presentation of the pathology of bone in terms of its anatomy and of the anatomic basis of physical examinations and clinical tests is instructive. A discussion is offered of the anatomy of various diseases such as internal hernias, backache and disk lesions, cold abscesses of the spine and subphrenic abscesses.

The literature quoted is mostly of British origin and somewhat antiquated. Insufficient attention is paid to recent advances in several fields of interest to the radiologist. Thus the chapter on epiphyseal ossifications does not include any reference to the recent monumental work of Greulich, Pyle, and Hoerr. The book will be appreciated particularly by students, residents and candidates for board examinations for whose needs schematization and didactic presentation is quite desirable. One of the great assets of the book has always been its diagrammatic, but very useful and original, line drawings which have become part of the teaching armamentarium of anatomists and surgeons of the English speaking world.

E. LACHMAN, M.D.

TUMORS OF THE SKIN. ATLAS OF TUMOR PATHOLOGY. Section I—Fascicle 2. By Herbert Z. Lund, M.D., Director of Laboratories, The Moses H. Cone Memorial Hospital, Greensboro, North Carolina; Visiting Professor of Pathology, University of North Carolina, Chapel Hill, North Carolina. Paper. Price, $3.00. Pp. 330, with 265 illustrations. Published by the Armed Forces Institute of Pathology under the Auspices of the Subcommittee on Oncology of the Committee on Pathology of the National Research Council, Washington, D. C., 1957. For sale by the American Registry of Pathology, Armed Forces Institute of Pathology, Washington 25, D. C.

This fascicle deals with a broad field of skin lesions known to be tumors and those conditions which either precede them or resemble them in gross and microscopic appearance but which still occupy an uncertain and disputed position,

being either developmental anomalies or reactive hyperplasias.

The terminology here has been a particularly difficult problem, partly due to the traditional use of dermatologic rather than histopathologic terms and partly due to the semantic difficulties of describing any particular lesion with reference to the original definition, gross and microscopic appearance, variations, and possibly etiology. Since the variations are quite numerous, especially in the so-called "adnexal tumors" of the skin, this has become a very complicated and confusing subject. This group of lesions is given full consideration.

Chronic dermatosis and changes leading to malignant transformation are fully described including various conditions such as solar keratosis, arsenical dermatosis, tar and oil dermatosis, burns, and chronic osteomyelitis.

The effects of roentgen rays upon the skin are given particular attention, using diagrammatic drawings of the initial injury, chronic dermatitis, and the development of epithelial neoplasms. In this connection, it is interesting to note that squamous cell carcinomas of the skin which are the result of the action of roentgen rays may contain fibrosarcomatous elements just as well as the original squamous cell carcinomas treated by roentgen therapy and that it is difficult, if not impossible, to differentiate between anaplastic, epithelial, and connective tissue components.

Benign and malignant mesodermal tumors are described and secondary tumor metastases in the skin are mentioned.

For completeness, numerous hyperplastic lesions of the fibroepithelial type, some of viral origin and some of unknown etiology, are also included.

This fascicle which is the largest in this series deals with very diversified material. It is richly illustrated and contains a large number of references from the world literature. It is particularly valuable because of the excellent illustrations of gross specimens and the numerous photomicrographs and because the whole subject is approached and viewed from the modern histopathologic standpoint.

J. R. McDonald, M.D.

Fortschritte der Kiefer- und Gesichts-Chirurgie; Ein Jahrbuch. Volume IV. By Prof. Dr. Karl Schuchardt, Direktor der Klinik und Poliklinik für Zahn-, Mund- und Kieferkrankheiten der Universität Hamburg und der Nordwestdeutschen Kieferklinik. Cloth. Price, DM. 124.—. Pp. 441, with 314 illustrations and 20 tables. Georg Thieme, Herdweg 63, Stuttgart, Germany, 1958.

It is a pleasure to review again the fourth volume of this book, which is actually a collection of Papers presented at Munich in July of 1957 by many different physicians interested in the subject of maxillofacial disease as well as disease of the facial skeleton and skull. It is a subsequent edition to, and an amplification of, the same type of book published the year before which dealt with malignant tumors. This volume written by a distinguished group of collaborators is chiefly concerned with benign tumors. It is basically a book on the indications and techniques of operative procedures on the growing face and skull, and particularly the facial skeleton.

The first article, for example, deals with the development of the vertebrate embryo and the results of recent biochemical investigations of early embryonic life. The developmental anomalies observed after exposing young amphibian and chick embryos to oxygen deficiency are described, with special reference to malformations of the head. It is felt that exogenous factors play an important role as causes of congenital malformations, in that the oxygen supply to the embryo is disturbed.

This is followed by an article on the development of the facial skeleton and its disturbances. This is profusely illustrated with diagrams, charts and comments, as well as roentgenographic reproductions of all kinds. It is pointed out that mastication, respiration and speech play a part in modifying the form of the facial skeleton, as does disease and premature closure of synchondrosis by ossification.

Other articles discuss *in extenso* plastic and facial corrections, as well as nasal surgery, the handling of infections of the sinuses, and benign tumors. The question of antibiotics is considered, and one author feels that the use of antibiotics should be restricted to penicillin in adequate dosage. One splendid article on anesthesia in young children comes to the conclusion that open or endotracheal methods are preferable. Since even slight obstructions in the airways carry very grave risk of anoxia, fairly large endotracheal tubes should be used. Occasionally, rectal administration of thiobarbiturates produces good results.

Another article details the electron microscope findings of the buccal mucosa. The observation that the electron miscroscope picture of leukoplakia closely resembles that of squamous cell carcinoma, should be of general interest.

The book is beautifully bound, lies open nicely on the table, is of convenient thickness for handling and holding, and is beautifully printed on an unusually good grade of paper. The diagrams are clear, the many photographs excellent, and the observations well summarized in three languages at the end of each article. It should be of interest to pathologists, surgeons, especially oral and plastic surgeons, otolaryngologists, orthodontists, pediatricians, speech therapists and radiologists as well as to the profession as a whole.

EUGENE A. OSIUS, M.D.

TUMORS AND TUMOROUS CONDITIONS OF THE BONES AND JOINTS. By Henry L. Jaffe, M.D., Director of Laboratories and Pathologist, Hospital for Joint Diseases, New York, New York; Consultant, Armed Forces Institute of Pathology, Washington, D. C. Cloth. Price, $18.50. Pp. 629, with 701 illustrations. Lea & Febiger, Washington Square, Philadelphia 6, Pennsylvania, 1958.

In the huge hiatus of medical knowledge in the field of bone physiology and pathology, Dr. Jaffe's book has filled an important segment of the breach with its integrated account of the tumors and tumorous conditions which affect the bones and joints. The perplexing problem of bone and joint tumors is put in its proper perspective by special chapters on such related conditions as bone cysts, fibrous dysplasia, leukemia and lymphoma, chordoma, tumors developing at sites of pre-existing bone disease, radiation injury and postradiation sarcoma of bones, tumors invading bones from overlying soft parts, and tumors metastatic to the skeleton. A special chapter on lesions peculiar to the jawbones points out lesions which are distinctive here and not merely jawbone localizations of lesions usually occuring elsewhere in the skeleton. Congenital, metabolic, inflammatory and traumatic lesions of bone in general are outside the scope of the book except for an occasional reference to some related condition.

The typical chapter is subdivided into discussions of nomenclature, incidence, localization in the skeleton, clinical complaints and findings, roentgenographic findings, gross pathology, microscopic pathology, nature and genesis, histologic pattern in relation to clinical behavior, and differential diagnosis and treatment. The many excellent illustrations of the roentgenographic, gross pathologic and microscopic appearance of the lesions are arranged on full page plates to permit their simultaneous display for purposes of comparison. The presentations have been guided throughout by the idea that the problems of diagnosis and differential diagnosis raised by the skeletal tumors can best be met if, in the interpretation of a given lesion, its clinical, roentgenographic, and pathologic features are considered and evaluated together. In regard to treatment, attention is devoted mainly to the choice of procedure appropriate for each condition.

Essentially, the book conveys the author's personal conceptions of the lesions discussed. Due credit has been given to other investigators in the field for work they have done, and, where pertinent differences in opinion exist, these have been pointed out and debated. A very adequate detailed bibliography is available at the end of each chapter and an extensive cross index makes for easy location of subject matter.

This book is highly recommended to pathologists, radiologists and orthopedic surgeons for easy reference in their day to day practice.

DONALD M. MONSON, M.D.

THE CERVICAL SYNDROME. By Ruth Jackson, B.A., M.D., F.A.C.S., Clinical Assistant Professor of Orthopaedic Surgery, The University of Texas, Southwestern Medical School, Dallas; Attending Orthopaedic Surgeon, Baylor University Hospital. Second edition. Cloth. Price, $6.50. Pp. 197, with 90 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1958.

The cervical syndrome is defined by Dr. Jackson as a group of symptoms or clinical findings caused by irritation or compression of the cervical nerve roots in or about the intervertebral foramina. In 174 pages, clearly and adequately illustrated by roentgenographic reproductions, diagrams, and photographs, she covers the subject from basic anatomy through treatment and prognosis in a logical and coherent manner.

The pertinent anatomic features of the cervical spine are described, including the two

lateral intervertebral synovial joints, which are peculiar to the cervical portion of the spine. Nerve root compression or irritation may be due to various malalignments, or may result from inflammatory reaction in the lateral intervertebral joints secondary to trauma or infection. Progressive mechanical and inflammatory changes may result from a seemingly innocuous trauma, or such chronic minimal traumata as poor posture. The symptoms are clearly correlated with the involvement of the cervical nerve roots and the sympathetic chain, and the discussion of differential features by which these symptoms can be distinguished from similar pictures is excellent.

A system for recording the history and methods of clinical and roentgenographic examinations which has been used by the author is described in detail.

Definitive and individualized treatment is stressed, with emphasis on conservatism (as opposed to surgery) and management that minimizes late degenerative changes and permanent ligamentous and capsular damage. Specific directions for the use of traction are well illustrated, and are accompanied by a warning against misuses of traction.

This book is of value to the radiologist, not merely for the radiologic chapter, but particularly for the splendid correlation of mechanical changes and symptoms, and the consideration of time relationships. It is a definite contribution to the diagnosis and treatment of the cervical syndrome.

Lois Cowan Collins, M.D.

Klinisch-röntgenologische Differentialdiagnostik der Lungenkrankheiten. By Dr. Lasar Dünner, Chefarzt der Industrial Chest Diseases Clinic in Hull (England), früher ärztl. Direktor des Hospitals Buch-West in Berlin, dirig. Arzt der Abt. für Lungenkrankheiten im Jüdischen Krankenhause in Berlin. Cloth. Price, DM 69.—. Pp. 362, with numerous illustrations. Ferdinand Enke Verlag, Hasenbergsteige 3, Stuttgart-W, Germany, 1958.

The second edition of this book, which first appeared and was reviewed in 1954, is considerably enlarged with about one-third of the text and about 120 illustrations added. There are now 439 excellent reproductions of roentgenograms, illustrating 212 cases. The case histories are grouped together at the end of each of the 24 chapters and they are the outstanding feature of the book.

The material is again presented in the same unusual and somewhat disorganized way as in the first edition. The chapter headings vary from discussion of symptoms, such as "Pain," "Blood Spitting," etc., to anatomic location of clinical findings, such as "Processes in the Apices," "Processes Below and Above the Diaphragm," etc., and then to clinical entities, such as "Lobar Pneumonia" and "Bronchial Carcinoma"; but a considerable amount of clinical information is included. Emphasis is placed on laminagraphy and this technique is well illustrated. Many new entities are described and an entire new chapter on the pneumonoconioses has been added.

The author mentions in the preface that the book is not complete and some of the less common diseases, such as lipiodol pneumonia and the mycotic infections, are discussed only very briefly. The book is written mainly for the internist and pediatrician, but the roentgenologist who is sufficiently acquainted with the German language will find it of interest and will profit from the study of the many roentgenograms and the varied case histories. References to the literature and suggestions for further reading are omitted from the book. They could be added easily and would enhance the value of further editions.

Egon G. Wissing, M.D.

Serological Studies of Human Blood Platelets. By Jon Lundevall. The Scandinavian Journal of Clinical & Laboratory Investigation. Vol. 10—Supplementum 34. Paper. Pp. 122. Oslo University Press, Oslo, Norway, 1958.

The investigation of the actions of human auto-agglutinins of various kinds has become very extensive in recent years. This monograph details the experiments of the author in the study of blood platelets in relation to their behavior in the presence of platelet agglutinins. A brief review of the problem and the pertinent literature precedes the details of each series of experiments. One of the most troublesome and confusing features of work with platelets is the nonspecific clumping which occurs both in saline solutions and in serum or plasma. The first section of the monograph presents the results of experiments to determine the nature of factors influencing this nonspecific clumping

and to devise a suitable procedure for preventing occurrence of this phenomenon. The addition of the disodium salt of ethylene diamine tetracetic acid (EDTA) to serum in appropriate concentration eliminates its platelet-clumping ability completely and is not only more satisfactory but also less cumbersome than other methods advocated.

Having arrived at a satisfactory method of avoiding nonspecific clumping, the second part of the presentation is devoted to a detailed study of the action of platelet agglutinins. A slide agglutination method with agitation was used for the study of agglutinating antibodies (equivalent to bivalent or saline antibodies such as seen in the Rh system), and an antiglobulin consumption test was used for the study of nonagglutinating platelet antibodies (equivalent to univalent or blocking antibodies in the Rh system). The frequency of direct acting platelet agglutinins in 978 individuals was 9.5 per cent and all were active at low temperatures. None was active at 37°C. The occurrence of the agglutinins was independent of diseases, pregnancies or previous transfusions, and thus it was concluded that the platelet agglutination test was of minor clinical interest. A small number of patients with nonagglutinating antibodies was studied by using the antiglobulin consumption technique. The results showed that these nonagglutinating antibodies occur in three categories of patients: patients with a normal platelet count who had had multiple transfusions, thrombocytopenic patients who had never been transfused or pregnant, and thrombocytopenic patients who had had multiple transfusions. The clinical significance of these antibodies was considered doubtful partly because the antiglobulin consumption technique is complicated and subject to misleading results, and partly because decreased platelet survival time was demonstrated by isotope studies in some cases in which no antibodies could be demonstrated. Abnormal destruction of platelets, therefore, does not always depend on antigen-antibody reactions.

The author is to be complimented on the meticulous way in which he carried out his experiments. The paper is easily read and is recommended to all who are interested in the problem of auto-antibodies in general and platelet antibodies in particular.

A. R. W. Climie, M.D.

BOOKS RECEIVED

Ergebnisse der gesamten Tuberkulose—und Lungenforschung. Volume XIV. By St. Engel, London, L. Heilmeyer, Freiburg i. Br., J. Hein, Tönsheide, and E. Uehlinger, Zürich. Cloth. Price, $34.30. Pp. 735, with 283 illustrations. Georg Thieme Verlag, Herdweg 63, (14a) Stuttgart, Germany, 1958.

The Pneumoconiosis Problem: With Emphasis on the Role of the Radiologist. By Eugene P. Pendergrass, M.D., Professor of Radiology, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania. Cloth. Price, $6.75. Pp. 146, with numerous illustrations. Charles C Thomas, Publisher, 301–327 East Lawrence Avenue, Springfield, Ill., 1958.

Treatment of Cancer and Allied Diseases. Second edition. Volume II. Tumors of the Nervous System. By Thirty Authors. Edited by George T. Pack, M.D., F.A.C.S., Attending Surgeon, Memorial Center for Cancer and Allied Disease; Clinician, Sloan-Kettering Institute for Cancer Research; Associate Professor of Clinical Surgery, Cornell University Medical College; Surgeon, Pack Medical Group, New York, and Irving M. Ariel, M.D., F.A.C.S., Associate Clinical Professor of Surgery and Associate Attending Surgeon, New York Medical College, Flower and Fifth Avenue Hospitals; Surgeon, Pack Medical Group, New York. Cloth. Price, $15.00. Pp. 316, with 340 illustrations. Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, 49 East 33rd Street, New York, N. Y., 1959.

Gynecologic Radiography: Including Radiography of the Breast. By Jean Dalsace, M.D., Chief of Sterility Service, Broca Hospital, University of Paris, Paris, and J. Garcia-Caldéron, M.D., Radiologist, University of Paris School of Medicine, Paris. Cloth. Price, $8.00. Pp. 188, with 360 illustrations. Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, 49 East 33rd Street, New York, N. Y., 1959.

X-Ray Diagnosis of the Alimentary Tract in Infants and Children. By Edward B. Singleton, M.D., Director of Radiology, Texas Children's and St. Luke's Hospitals, Houston, Texas; Clinical Assistant Professor of Radiology, Baylor University College of Medicine; Clinical Associate Radiologist, University of Texas Post Graduate School. Cloth. Price, $11.00. Pp. 352, with numerous illustrations. The Year Book Publishers, Inc., 200 East Illinois Street, Chicago, Ill., 1959.

Chronic Subdural Hematoma: With Particular Reference to the Diagnosis: A Clinical, Roentgenological and Electroencephalographical Study. By Ragnar Nordlie. Paper. Pp. 164, with 24 illustrations. Johan Grundt Tanum Forlag, Oslo, Norway, 1958.

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

Head

Mounier-Kuhn, P., Gaillard, J., Bonnefoy, J., and Lafon, H. (Lyon, France.) Les tomographies du cavum, de la face et de la base du crâne en position de Hirtz. (Tomography of the cavum, of the facial bones, and of the base of the skull in the Hirtz position.) *Ann. d'oto-laryng.*, Sept., 1958, *75*, 582–591.

Laminagraphy of the base of the skull in the Hirtz position may be a valuable adjunct in investigating the possible involvement of the rhinopharynx, posterior part of the ethmoid and maxillary sinuses, and the pterygo-maxillary space by tumoral processes.

This procedure may give information not obtainable by ordinary roentgenography of the skull or by direct examination.

The patient is placed in the sitting position with maximum extension of his head. Laminagrams are made at 13, 14 and 15 cm. below the vertex. Polytome is preferred in order to eliminate blurring effects. In this way, osseous as well as soft tissue structures may be studied. A series of observations exemplify the use of that technique.—*H. P. Lévesque, M.D.*

Freeman, Bromley S. Sialography in children. *Surg., Gynec. & Obst.*, Oct., 1958, *107*, 505–507. (From: The Department of Surgery, Division of Plastic Surgery, Baylor University College of Medicine, Houston, Tex.)

The author notes that little could be found in the literature describing the use of sialography in children. This procedure isolates the gland and shows whether or not the parenchyma is intact and if the margins are normal, compressed, or invaded. It is an aid in planning an operative method. Although the ducts of children are tiny, a satisfactory method without the use of general anesthesia is described. The general technique of the procedure is discussed in some detail, including premedication, local anesthesia of the duct openings, gradual dilatation of the sphincters, and slow injection of a contrast material of low viscosity by means of simple readily available apparatus. With proper sedation, instruments, and radiopaque materials, it has been possible to obtain good studies in children as young as eighteen months of age.

It is stated that certain minor points of technique, when sedulously applied, will produce a relatively tranquil diagnostic study, often quite useful and frequently with less discomfort to the patient, technician, and operator, than a chest roentgenogram of the same individual. The use of sialography can be extended to children to aid in the diagnosis of any questionable mass around the region of the salivary glands with little trauma, either mental or physical, and occasionally may prevent exploratory surgery. The findings in 5 patients are discussed briefly to illustrate the indications and results. Photographs and reproductions of roentgenograms are included.—*D. S. Kellogg, M.D.*

Neck and Chest

Maurath, J., Rüger, R., and Schmidt, H. Über die Verschieblichkeit des menschlichen Mediastinum und ihre Bedeutung für die Thoraxchirurgie. (On the mobility of the human mediastinum and its significance for thoracic surgery.) *Thoraxchirurgie*, July, 1958, *6*, 53–62. (Address: Chirurgische Universitätsklinik, Tübingen, Germany.)

The mediastinum is rather well fixed in adults, in inspiration as well as expiration. With forced deep inspiration there is a very slight lateral displacement of the esophagus and the vessels of the mediastinum toward the right. If a main bronchus is obstructed, there is marked mediastinal shift, observable by roentgen diagnostic means.

The method used by the authors to demonstrate an abnormal fixation of the mediastinum is described as follows: During preoperative lung function studies by spirometry each main bronchus consecutively is blocked. In a normal mediastinum the trachea and blocked main bronchus move during inspiration toward the blocked side. If there is mediastinal fixation, there is no mobility or the mobility is decreased.

This type of examination has been of value in cases of carcinoma of the lung to determine mediastinal metastatic involvement. The surgical findings proved the value of this special examination. Thirty-three of the 43 patients with cancer of the lung and nonmovable mediastinum proved to be inoperable. In some cases of cancer of the esophagus, these findings were also helpful. Mediastinal tumors, even of large size, were found to be operable when there was normal mobility of the mediastinum.

In inflammatory diseases of the lungs, pleural and mediastinal scarring may or may not lead to a relative fixation of the mediastinum.—*Hans W. Hefke, M.D.*

Shapiro, Jerome H., Jacobson, Harold G., Stern, Wilhelm Z., and Poppel, Maxwell H. Posterior mediastinal goiter. *Radiology*, July, 1958, *71*, 79–84. (Address: J. H. Shapiro, Montefiore Hospital, 210th St. and Bainbridge Ave., New York 67, N. Y.)

The posterior mediastinum is an infrequent site for an enlarged thyroid and a correct preoperative diagnosis of an enlarged thyroid in this location is necessary to determine the proper surgical approach. The authors present 5 cases of proved posterior medi-

astinal goiters with illustrative roentgenograms of 4 of them.

The roentgen appearance is that of a homogeneous, circumscribed density located behind the trachea and near the midline but frequently more prominent on the right. If the goiter is posterior to the esophagus, there is anterior displacement and bowing of the trachea and esophagus in addition to the lateral deviation. When the goiter is located between the trachea and the esophagus, these structures are displaced in opposite directions, the former anteriorly and the latter posteriorly.

The differential diagnosis of intrathoracic goiter includes mediastinal tumor (neurofibroma, dermoid, teratoma, and thymoma), cysts (bronchogenous and enterogenous), aneurysm of the aortic arch and its major divisions, lymph node masses (malignant lymphoma, metastatic cancer, sarcoid), and bronchogenic carcinoma. Laminagraphy and occasionally angiocardiography may aid in the diagnosis.—*Donald N. Dysart, M.D.*

Gremmel, H., Rotthoff, F., and Willmann, K. H. Intrathorakale Lipome. (Intrathoracic lipomas.) *Thoraxchirurgie*, July, 1958, *6*, 75–85. (Address: H. Gremmel, Institut und Klinik für Medizinische Strahlenkunde der Medizinischen Akademie, Düsselforf, Germany; F. Rotthoff and K. H. Willmann, Chirurgische Klinik der Medizinischen Akademie, Düsseldorf, Germany.)

A series of 9 cases with intrathoracic lipomas, which were seen by the authors during the last eight years, are reviewed. Only two of these were true mediastinal lipomas.

Clinical symptoms depend on the location of the tumor. The patients' complaints were dyspnea, cough and dysphagia. Roentgenologically, the most common localization was in the right cardiophrenic angle. A preoperative diagnosis by clinical and roentgenologic means was often impossible. Surgical removal in all cases showed fatty tumors.—*Hans W. Hefke, M.D.*

Sixt, Konrad. Die Röntgenreihenuntersuchungen in Bayern. (Mass roentgenographic examinations in Bavaria.) *Tuberkulosearzt*, March, 1958, *12*, 161–173. (Address: Brienerstr. 55, München 22, Germany.)

Since 1954 routine chest examinations are obligatory in Bavaria for all inhabitants over ten years of age. Seven mobile mass roentgenographic units are in operation, equipped with Siemens-Odelca apparatus. With each unit approximately 150,000 roentgenograms were taken each year. The whole population will be examined in six to seven years.

The author reviewed a total of 1,727,697 roentgenograms, taken in 1956–57. The coverage was 90–95 per cent; 3.1 per cent were re-examined. An incidence of 0.1 per cent of cavitary tuberculosis was found; the incidence of active noncavitary lesions was 0.21 per cent and of inactive lesions 0.83 per cent. Fifty-one per cent of all active cases required treatment in sanatoria; 0.43 per cent had other previously undetected pulmonary or cardiovascular pathology.

The number of new cases of tuberculosis increased markedly with age, which points to the need for increased awareness of the danger of tuberculosis in the elderly.—*Karol E. Matzinger, M.D.*

Chace, John F., Rockoff, S. David, and Hellman, Louis P. Pulmonary infiltration and fibrosis of unknown etiology; the risk of developing active pulmonary tuberculosis. *A.M.A. Arch. Int. Med.*, Sept., 1958, *102*, 367–374. (From: Department of the Navy, Bureau of Medicine and Surgery, Washington 25, D.C.)

This is a study of a group of patients found to have roentgenographically unchanging chest lesions for which no specific bacteriologic or pathologic diagnosis could be made. These had been classified as "infiltration, pulmonary, cause undetermined."

The study group and a control group were on active duty in the Naval and Marine Corps. All cases with a previous diagnosis of active tuberculosis were excluded. The study group had been evaluated with serial roentgenograms over several months, as well as suitable bacteriologic examination; 5.9 per cent (out of 268 cases) was found to have or to have developed pulmonary tuberculosis after return to duty. No cases were found in the control group.

The study indicates the difficulty of establishing a diagnosis of pulmonary tuberculosis in cases with lung lesions, even when this diagnosis is strongly suggested roentgenologically.—*George L. Sackett, Jr., M.D.*

Sanghvi, L. M. Loculated interlobar effusion associated with pericarditis; report of two cases. *A.M.A. Arch. Int. Med.*, Sept., 1958, *102*, 447–449. (From: Department of Cardiology, Sawai Man Singh Hospital and Medical College; Additional Professor of Medicine, Jaipur, India.)

Loculated interlobar effusion has been frequently reported associated with heart failure, but not with pericarditis. The author reports two cases associated with pericarditis occurring after previous pulmonary congestion had been relieved. Both cases had recurrences of acute pericarditis. In one case it was due to rheumatic fever, in the other, to tuberculosis.

The roentgenographic appearance was that usually associated with "vanishing tumor" or loculated inter-

lobar effusion seen in congestive heart failure.—*George L. Sackett, Jr., M.D.*

Glennie, J. S., and Moghissi, K. Leiomyoma of oesophagus; report on two cases surgically treated. *Brit. M. J.*, Aug. 23, 1958, *2*, 484–487. (From: Thoracic Surgical Unit, Blackpool Victoria Hospital, Blackpool, England.)

This is a report of 2 patients with leiomyoma of the esophagus treated successfully by surgery.

Both patients had a common history of dysphagia and both demonstrated a rounded filling defect in the esophagram, one in the superior third and one in the middle third of the esophagus. The defects were smooth and suggested extrinsic pressure. There were minimal findings at esophagoscopy. Both patients were surgically explored and the masses shelled out of the tissues quite easily. Both patients recovered completely and had normal barium studies subsequently.

Leiomyoma is the most common benign tumor of the esophagus and in the majority of reports has been usually found in the lower or middle third of the esophagus. In the above cases it was in the upper and middle thirds. The lesion occurs more often in males than in females and the most common symptom is dysphagia. Physical examination is usually negative as are laboratory findings. Esophagoscopy is indicated to rule out the possibility of carcinoma. Roentgenographically, the filling defects have ordinarily a smooth surface and cause a ring or arc shadow in the barium column due to the pressure.

Enucleation is the treatment of choice with an operative mortality rate of 9 per cent. The mortality rate is higher if excision is done.—*Stephen Bruny, M.D.*

Abdomen

Guien, C., Legré, J., Sarles, J. C., and Sarles, H. (Marseille, France.) Valeur diagnostique de l'étude radiologique de l'estomac et du duodénum, au cours des pancréatites chroniques; (à propos de 27 observations personnelles de diagnostic certain). (The diagnostic value of radiologic study of the stomach and duodenum in chronic pancreatitis; 27 personal observations with correct diagnosis.) *J. de radiol., d'électrol. et de méd. nucléaire*, Aug.–Sept., 1958, *39*, 473–480.

The authors present 27 cases of chronic pancreatitis, of which 15 were lithogenous and 12 were without any pancreatic calculi.

Upper gastrointestinal study revealed roentgenographic signs of certainty in 74 per cent of cases, whereas laboratory procedures furnished only 60 per cent of positive diagnostic findings. Since the presence of pancreatic calculi ensures a diagnosis of chronic pancreatitis, it is only in the cases where no calculi could be demonstrated that the upper gastrointestinal tract study would be of maximum value.

In the experience of the authors the following are some of the important roentgenographic findings in cases of nonlithogenous chronic pancreatitis: Extrinsic pressure deformity of the body and lesser curvature of the stomach was observed in 3 cases of chronic pancreatitis with voluminous cysts. In 7 other cases of chronic pancreatitis without cysts, the deformity observed was in the prepyloric antral region and along the greater curvature of the distal part of the stomach. These imprints are sometimes arch-like and sometimes straight. At times there is rigidity of the prepyloric antrum. Deformity in the prepyloric antrum, as well as in the region of the duodenum, is much more frequent than in the region of the body of the stomach. Deformity due to compression by the spine and other organs should be carefully ruled out. The measurement of the prevertebral and retroantral space is of no definite value. The duodenal contour changes are of greater diagnostic significance according to the authors. There is enlargement and a rounded appearance of the duodenal loop, both in the upright and decubitus positions. More important are the modifications of the mucosal pattern of the duodenum, which usually precede the enlargement of the loop. In 4 cases the lesser curvature or upper border of the duodenal cap was straight, horizontal and rigid, whereas the lower border of the duodenal cap had a wavy appearance. In 8 cases there was arch-like compression of the borders of the duodenal bulb: in 2 cases the lesser curvature was affected, in 5 cases the greater curvature and in 1 case both curvatures. In another 4 cases there was a pseudofilling defect; in 2 of these cases surgical intervention proved that this filling defect was due to prominence of the pancreas along the posterior surface of the duodenal bulb. Polyp or tumor may be ruled out by observing the change in the position of this pseudofilling defect, as the patient's position is changed for roentgenography. In 3 of the cases the entire bulb was compressed, due to rather large cysts of the pancreas.

The authors compare these changes with those found in another series of 100 cases where no pancreatitis was suspected and where only 4 of the cases showed similar alterations in the duodenal bulb. Of these 4 cases, all of which had bulbar changes due to chronic duodenal ulcer, pancreatic irritation was present in 1 case. In 13 cases there was effacement of the mucosal pattern of the second portion of the duodenum, with rigidity and sharpness of border. In 6 of these cases there was slight arch-like imprint along the medial wall of the duodenum.—*Jirair N. Sarian, M.D.*

Daffner, John E., and Brown, Charles H. Regional enteritis. I. Clinical aspects and diagnosis in 100 patients. *Ann. Int. Med.*,

Sept., 1958, *49*, 580–594. (From: The Department of Gastroenterology, The Cleveland Clinic Foundation, and The Frank E. Bunts Educational Institute, Cleveland, Ohio.)

The authors report a careful clinical study of 100 cases of regional enteritis studied in Cleveland between the years 1946 and 1956. The group contains a predominance of young adults in the middle and upper economic strata, almost equally divided as to sex. It is pointed out that nonspecific symptoms such as fever, anemia and mild diarrhea may often precede clinical diagnosis by several years. The true nature of the illness may escape detection until the complications of obstruction, bleeding or fistula formation occur and demand attention.

Rather characteristic pain and diarrhea occurred in over 80 per cent of the patients. The pain was periumbilical or in the right lower abdominal quadrant and was usually crampy. Diarrhea was described typically as two to five mushy or liquid stools a day with mucus and occasional blood. Of a total of 48 fistulae, 21 were classed as fistula in ano. A small group suffered associated lesions classed as systemic complications, the commonest of which was rheumatoid arthritis occurring in 8 patients.

Physical findings were limited to the palpation of a mass, detection of fistulae or the diagnosis of obstruction. In the presence of obstruction, plain roentgenograms of the abdomen were invaluable. Since 98 per cent of lesions involved the terminal ileum, the opaque enema is considered of first importance in roentgen diagnosis. The lesion can thus be demonstrated with relative ease and one obviates the hazards of placing barium behind a partial obstruction. Otherwise, small bowel motility studies are of value.

The authors state that these examinations suggest or establish the diagnosis in about 55 per cent of the cases studied.—*James A. Martin, M.D.*

Brown, Charles H., and Daffner, John E. Regional enteritis. II. Results of medical and surgical treatment in 100 patients. *Ann. Int. Med.*, Sept., 1958, *49*, 595–606. (From: The Department of Gastroenterology, The Cleveland Clinic Foundation, and The Frank E. Bunts Educational Institute, Cleveland, Ohio.)

In a second article the authors report the results of medical and surgical therapy in 100 previously described cases of regional enteritis. Medical therapy was supportive and nonspecific, and was applied to the uncomplicated illness only. High caloric, low fat and low residue diets were augmented by mild sedation, antispasmodic or anticholinergic drugs, antibiotics and in some instances by steroids. Of interest is the fact that 6 patients received roentgen therapy. This was considered of some value in the acute ulcerative phase presumably to counteract lymphoid hyperplasia and lymphocytic infiltration in the bowel. While 3 of these patients appeared to respond satisfactorily, 1 exhibited no response and 2 required surgery to correct subsequent obstruction and rectal bleeding. Proper evaluation of the treatment is difficult since these cases were also receiving other types of therapy concomitantly. Of 35 patients treated medically, 26 were followed adequately. Of these, 23 responded satisfactorily without recurrence in two to eight years.

Surgical therapy, preferably resection, was offered to 65 patients who had severe disease complicated by obstruction, abscess formation or fistulae. Of this group, response was considered satisfactory in 76 per cent of those available for follow-up studies. Two deaths were the result in each case of gastrointestinal neoplasm and not of the enteritis. However, the postoperative recurrence rate was high. Approximately half of these were treated medically, the remainder by further surgical procedures and a rather high rate of satisfactory response was obtained.

The authors feel on the basis of this combined experience that the general attitude of pessimism toward this disease is unwarranted.—*James A. Martin, M.D.*

Kaufman, S. A., and Levene, George. Esophageal moniliasis: Report of a case with roentgenographic findings. *Ann. Int. Med.*, Sept., 1958, *49*, 684–687. (From: The Departments of Radiology of the Massachusetts Memorial Hospitals and Boston University School of Medicine, Boston, Mass.)

Esophageal infection with *Candida albicans* although extraordinarily rare, apparently produces changes of rather characteristic nature roentgenographically. Mucosal ulceration is reflected in the barium swallow as an irregular, ragged outline of the thoracic esophageal lumen.

The authors report the case of a debilitated young male with leukemia and extensive monilial esophagitis. In this instance the additional findings of rigidity and extensive narrowing were the result of pseudomembrane formation throughout the entire thoracic esophagus. It is stressed that any chronically debilitated patient receiving extensive antibiotic therapy who complains of dysphagia or other symptoms of esophageal irritation should be examined roentgenographically.—*James A. Martin, M.D.*

Janbon, M., and Bertrand, L. (Montpellier, France.) Sarcoïdose de l'intestin grêle; (ses rapports avec l'iléite régionale de Crohn). (Sarcoidosis of the small intestine. [Its relation to Crohn's regional ileitis].) *Presse méd.*, Oct. 1, 1958, *66*, 1491–1494.

This is a presentation of a case of sarcoidosis of the small bowel established by histologic examination.

The patient, a thirty year old woman, developed a subacute small bowel obstruction while she was under antituberculous treatment for a miliary involvement of the lungs. Four months before, she complained of attacks of enterocolitis characterized by intestinal spasms and diarrhea. She recently had sustained a weight loss of 25 pounds. A painful mass was palpated in her right lower quadrant and clinically a tuberculous cecal involvement was suspected. On account of a left thoracic pain, a chest roentgenogram was taken. This showed a dense and diffuse miliary process, supporting the previous diagnosis of suspected tuberculosis of the cecum. She was started on a two month antituberculous drug therapy but during that time she suffered an acute intestinal obstruction and was referred to the authors.

A follow-up chest roentgenogram showed a complete clearing of the miliary involvement. Repeated tuberculin tests were negative, search for tubercle bacillus in sputum, stools, gastric juice remained negative, as well as the inoculation of gastric juice. Hemagglutination test (Middlebrook-Dubos) was unexpectedly found at $\frac{1}{32}$. However, roentgenograms of the hand and feet revealed small radiolucent areas in the left tarsometatarsal bones.

Small bowel studies showed Koenig's syndrome and fluid levels. Barium was seen partially retained in the small bowel after seven days. At laparotomy, a segment of 15 cm. of stenosed terminal ileum was resected. Mutiple areas of parietal thickening were observed on the small bowel, mostly in the ileum, with many white spots between these thickened zones. A small amount of gelatinous ascites was also noted. The colon was normal except for an intumescent ileocecal valve. Histologic sections of the resected specimen were typical of sarcoidosis.

Small bowel barium studies were repeated a year later and showed only persistent thickening of the ileocecal valve with some parietal induration of the new terminal ileum. Fifteen days after operation, she was put on corticosteroids for one and one-half months. For the past four years, she has been considered clinically cured.

A review of the literature dealing with involvements of the digestive tract by sarcoidosis is given, followed by an interesting discussion of histologic differential diagnosis from regional enteritis or Crohn's disease.—*H. P. Lévesque, M.D.*

Elson, Matthew W. Cecal invagination by a mucocele of the appendix. *Radiology*, July, 1958, *71*, 90–92. (Address: Ohio State Medical Center, Neil and Eleventh Avenues, Columbus 10, Ohio.)

The author reviews the etiology, symptomatology and pertinent clinical and roentgenologic findings of cecal invagination by a mucocele of the appendix. A case report of a thirty-three year-old white female is included. The incidence of mucocele has been reported to be 0.1 to 0.5 per cent in surgically removed appendices. Mucoceles arise in a gradual stenosis or obstruction of the proximal appendiceal lumen, with an actively secreting mucosa, leading to increasing distention of the appendix. As the mucocele develops and the tension within it increases, the thin diaphragm at its base is pushed into the lumen of the cecum and thus may become an invagination or intussusception.

The only positive physical finding may be a firm, globular, slightly tender mass in the right lower quadrant. Roentgenograms of the abdomen may reveal calcium deposits within the right lower quadrant mass, and on barium enema examination a sharply outlined soft-tissue mass is seen in the cecal region inseparable from the cecal wall. Or, if the cyst has invaginated into the cecum, the barium enema study will reveal a sharply defined polypoid, intraluminal cecal mass with no appendiceal filling.—*John S. Alexander, M.D.*

Hoch, A. P., and Foster, E. Über die Verwendung eines neuen mikronisierten Bariums (Barotrast) zur Röntgenuntersuchung unter spezieller Berücksichtigung der Colondarstellung mit Doppelkontrastmethode. (On the use of a new micronized barium [barotrast] for roentgen examination, with special reference to the colon visualization by the double-contrast method.) *Schweiz. med. Wchnschr.*, July 26, 1958, *88*, 730–736. (Address: A. P. Hoch, Röntgeninstitut, Bahnhofstrasse 24, Zürich, Switzerland, and S. F. Foster, 536 Mason Street, San Francisco, Calif.)

The experience of the authors with a new micronized barium (barotrast) is reported, especially when used for a double-contrast examination of the colon. The new preparation is believed to have a very good surface-covering ability, which remains intact after the injection of air for a double-contrast examination. The rectosigmoid junction, in particular, can be demonstrated more accurately, since the contrast material remains as a cover for the mucosa considerably longer than the straight barium mixture.

Technical problems of preparation, positioning and filming techniques are considered in detail.—*Hans W. Hefke, M.D.*

Salzman, Emanuel, and Warden, M. Robert. Telepaque opacification of radiolucent biliary calculi; the "Rim Sign." *Radiology*, July, 1958, *71*, 85–89. (Address: E. Salzman, Denver Hospital, West 6th Ave., and Cherokee St., Denver 4, Colo.)

The authors described a new sign—the "rim sign"—which consists of a sharp linear density around the periphery of a radiolucent biliary calculus which itself will show a slight generalized faint increase in density. This opacification phenomenon is thought to be due to deposition of telepaque or an iodinated product on the surface of the stone, and is obtained by repeating at least once or several times, at daily intervals, the usual 3 gm. dose of telepaque. This procedure may be of value in cases where initially no opaque calculi are visible and the gallbladder either did not visualize or was visualized only faintly after the conventional dose of telepaque.

Three cases are described where, following a three or four day regimen of 3 gm. of telepaque daily, 1 gm. after each meal, on a relatively fat-free diet, opacification of radiolucent stones was observed. In 2 of the patients common duct stones were found, and all had one or more stones in the gallbladder.—*Donald N. Dysart, M.D.*

Gynecology and Obstetrics

Sibthorpe, Elsie M. A radiological survey of the female pelvis in Uganda. *J. Obst. & Gynaec. Brit. Emp.*, Aug., 1958, *65*, 600–605. (From: Department of Obstetrics, and Department of Anatomy, Markerere College, University College of East Africa, Uganda, Africa.)

Roentgenographic pelvimetries were performed on 105 patients. Of these, 90 belonged to Bantu tribes and the results of their pelvimetric studies are reported.

It was found that the Bantu pelvis was generally contracted. The mean measurements of the main diameters are compared with other published surveys.

The clinical significance of this contracted pelvis is discussed with a note on fetal size and method of delivery. The roentgenologic data are compared with those of dry bone material.—*Eugene J. McDonald, M.D.*

Hay, David. The diagnosis and significance of minor degrees of uterine abnormality in relation to pregnancy. *J. Obst. & Gynaec. Brit. Emp.*, Aug., 1958, *65*, 557–582. (From: St. David's Hospital, Bangor, North Wales.)

With the exception of the series by Falls and Way and this present series, no report of a large personal collection of cases of minor degrees of uterine abnormalities in relation to pregnancy has appeared in the literature. The literature is already replete with isolated reports of pregnancies in abnormal uteri of one type or another and with small collections of the more advanced types of lesions.

There appears to be much confusion concerning the classification of the various types of uterine abnormalities and each successive writer, attempting to simplify the situation, has only added more confusion to the issue. The author has found the classification of Jarcho the most useful and descriptive, and, at the same time, most simple.

Sixty-five cases of minor degrees of uterine abnormalities in association with pregnancy found in an eighteen month investigation period are presented with their hysterograms and reviewed. Another 28 probable and a further 107 possible cases are referred to in the text. The incidence of the condition is thought to be in the neighborhood of 10 per cent.

It is advocated that the classification of abnormalities should be made on hysterography. Other methods, based on palpation of the uterus and visualization of the uterine surface, can be misleading. The dangers of the condition to mother and baby have been overemphasized in the past, as the majority of cases go through pregnancy and labor quite normally.

Evidence is presented to suggest that uterine abnormalities in association with extended legs are the primary cause of breech presentation.—*Eugene J. McDonald, M.D.*

Berridge, F. R., and Eton, Bruce. The accuracy of radiological estimation of foetal maturity. *J. Obst. & Gynaec. Brit. Emp.*, Aug., 1958, *65*, 625–630. (From: The Departments of Radiology and Obstetrics, United Cambridge Hospitals, Cambridge, England.)

Roentgenologic estimation of fetal maturity was carried out in retrospect in a series of 200 women in whom there was no doubt about the duration of pregnancy. The method consisted of simple inspection of the roentgenograms.

A study of the cases in which an erroneous estimate had been made led to the following conclusions: If, with the recent trend to reduce roentgen exposure in pregnancy, roentgenograms of poor quality or those taken for other purposes are utilized for estimating maturity, errors are more likely to be incurred. If the fetus is above average size, its maturity is liable to be overestimated and vice versa in the case of small fetuses. Malpresentation was a definite source of error, but not the sex of the fetus. Correct estimation of maturity was comparatively difficult between the twenty-eighth and thirty-third week of gestation. Maternal height did not influence the roentgenologic estimate. If the mother's weight was above average, there was a tendency to overestimate fetal maturity. The reverse was observed in thin women.

With good quality films the method of simple inspection probably does not lead to more errors than estimates based on measuring certain parts of the fetal skeleton. It would, therefore, seem unwise to disregard clinical features and base the management of a given case mainly on roentgenologic estimation

of fetal maturity, particularly if the roentgenograms are not of high quality.—*Eugene J. McDonald, M.D.*

Genitourinary System

Pendergrass, Henry P., Tondreau, Roderick L., Pendergrass, Eugene P., Ritchie, David J., Hildreth, Eugene A., and Askovitz, Samuel I. Reactions associated with intravenous urography: Historical and statistical review. *Radiology*, July, 1958, *71*, 1–12. (Address: R. L. Tondreau, Hospital of the University of Pennsylvania, Philadelphia 4, Pa.)

The authors report the results of a study of fatalities and unfavorable reactions associated with intravenous urography. Questionnaires addressed to members and fellows of the American College of Radiology and to the various interested pharmaceutic companies revealed a total of 86 deaths associated with the procedure of intravenous urography. Seventeen of these urographic deaths occurred during the years 1942 through 1952, but were not included in a previous survey of that period. Of the 69 urographic fatalities which occurred between Jan. 1, 1953 and April 6, 1957, 61 were immediate deaths. The histories of these 61 cases have been abstracted and are shown in tabular form. Over the entire fifteen year period, the total incidence of reported deaths following urography is 8.6 per million urograms.

Negative sensitivity tests were recorded in most of the immediate fatalities. Pretesting for sensitivity appears to be of little or no value, and failure to do pretesting is not to be regarded as neglecting the welfare of the patient. More important are sound clinical judgment and a careful clinical history, with particular emphasis upon allergy.

The data are not sufficient to determine relative toxicities of the various substances, but at least one fatality has occurred with each of the urographic media in common use today. While the absolute number of urographic fatalities per year has increased over the four year period from 1953 to 1956, it would appear that this increase is related to the greater use of urography and not necessarily to any increased toxicity of the urographic contrast media.—*Arno W. Sommer, M.D.*

Knoefel, Peter K. The nature of the toxic action of radiopaque diagnostic agents. *Radiology*, July, 1958, *71*, 13–14. (Address: 323 East Chestnut St., Louisville, Ky.)

So little information is available that discussions of the nature of the toxicity of radiopaque diagnostic agents must be largely speculative.

The author compares the characteristic curves of the acute lethal toxicity of iodopyracet in the rat and in man. He believes that some individuals who die have a quantitative idiosyncrasy, in that they respond in a manner in which all individuals would respond if given enough, but do so at a small dose. Another possibility is that the individuals who die have a qualitative idiosyncrasy, the so called "drug allergy." This is an atypical response which bears little relation to the dose. A remaining possibility is that of deiodination of the molecule in the body with a toxic reaction either to the iodine or to the remainder of the molecule.—*W. M. McBride, M.D.*

Finby, Nathaniel, Evans, John A., and Steinberg, Israel. Reactions from intravenous organic iodide compounds: Pretesting and prophylaxis. *Radiology*, July, 1958, *71*, 15–18. (Address: N. Finby, New York Hospital-Cornell Medical Center, 525 E. 68th St., New York 21, N. Y.)

Pretesting and prophylactic measures in contrast roentgenography are utilized to anticipate reactions and to avoid fatality. Minor reactions such as urticaria, sneezing, arm pain, rhinitis, nausea, vomiting and headache are usually transient. The frequency and intensity of these reactions depends upon the condition of the patient, the type of examination, the contrast medium used and the skill and experience of the physician. The major reactions are less frequent and are probably related directly to the organic iodide compound. Serious reactions which may occur are angioneurotic edema, anaphylactic shock, hypotension, shock, pulmonary edema and cardiac standstill. Drug idiosyncrasy, fever and convulsions may also occur.

There is no satisfactory test which will allow the prediction of a severe or fatal reaction. Intraoral, skin, eye and patch tests have proved unsatisfactory. The intravenous test with 1.0 cc. of the contrast medium may be of some value. Good clinical judgement and close supervision by a competent physician are important factors in the prophylaxis and treatment of severe reactions. It is important to detect the high-risk patient who requires hospitalization and special facilities. Patients who have a history of a previous severe reaction or who have allergic, renal, hepatic or cardiac disease must be studied under optimal conditions.

Premedication may alleviate apprehension, but no one medication can be relied upon to prevent reactions. Antihistamines should be reserved for therapy and are not recommended for prophylaxis of serious reactions. Variations in the speed of injection, the position of the patient and the temperature of the solutions have not resulted in greater safety. Preparation to recognize and treat reactions immediately is essential. A safety kit for emergency therapy should be available.—*W. M. McBride, M.D.*

Davis, Lawrence A. Reactions following excretory pyelography in infants and children.

Radiology, July, 1958, *71*, 19–20. (Address: 226 East Chestnut St., Louisville 2, Ky.)

The author analyzes the reactions associated with excretory pyelography in 300 examinations of infants and children. Urokon sodium (50 and 70 per cent) was used 241 times and hypaque (50 per cent) 59 times. The doses were given intravenously in amounts ranging from 5 cc. of the 70 per cent urokon to 20 cc. of the 50 per cent hypaque roughly according to the patient's age and weight. No pretesting for sensitivity was done and the injection was usually quite rapid. Only objective findings such as vomiting, cardiovascular reactions, neurologic abnormalities, and skin reactions were evaluated due to the age group of the patients.

In the 300 cases, there were 31 reactions, none of which was severe enough to warrant discontinuance of the examination. The skin reactions were mild, only 1 or 2 wheals being seen in most cases.

The author concludes that excretory pyelography is a safe procedure in infants and children.—*John S. Alexander, M.D.*

Weigen, John F., and Thomas, Sydney F. Reactions to intravenous organic iodine compounds and their immediate treatment. *Radiology*, July, 1958, *71*, 21–27. (Address: J. F. Weigen, Palo Alto Medical Clinic, Palo Alto, Calif.)

Reactions to intravenously administered organic iodides are extremely dangerous in that they occur without warning and become severe in a matter of seconds. Such a reaction may involve the cardiovascular, central nervous, or respiratory system or a combination of these. The proper immediate treatment of such a reaction must be based on teamwork and a carefully outlined plan of action which must be vigorous, yet controlled. The authors present in detail their own plan of treatment.

Of the major reactions "cardiovascular collapse" is the most common and requires immediate therapy to prevent anoxia of the brain and heart. The immediate steps, at the first indication of a fall in blood pressure, should consist of the following: remove encumbrances, administer oxygen, call for assistance by a prearranged signal, and record the blood pressure at the first practical opportunity. A vasodepressor is then administered intravenously (aramine, 2 to 3 mg.) and repeated in one minute if the blood pressure does not rise. If the blood pressure responds but is not sustained, give an intravenous infusion of the vasodepressor (aramine, 50 mg. in 500 cc. of physiologic saline) at a rate necessary to sustain systolic pressure at 90 to 120 mm. of mercury. In the event the blood pressure does not rise in one to five minutes following administration of the vasodepressor, give solu-cortef (100 mg. intravenously). Cardiac arrest may develop despite the above measures. In such an event one is confronted with the decision to use maximal medical efforts, such as blows to the heart through the chest wall and cardiac injection, or to resort to thoracotomy and cardiac massage. The decision, in part, should be made in advance due to the necessity of surgical instruments, skilled help, positive pressure oxygen apparatus and a plan for care of the patient, should cardiac action be restored. If cardiac massage is performed it should be instituted within a few minutes after the development of cardiac arrest, before permanent brain damage occurs.

Central nervous system reactions are manifested by marked restlessness, twitching or convulsions. These phenomena, especially convulsions, must be stopped since anoxia is increased by the associated apnea. The immediate steps, at the first signs of excessive central nervous system stimulation, should consist of the same procedure as discussed in cardiovascular collapse. If convulsions continue, give small intravenous doses of a barbiturate (nembutal, 25 mg. at two minute intervals) until the convulsions are controlled. If the respirations become depressed, apply artificial respiration only. The authors emphasize that respiratory stimulants have no place in the armamentarium for controlling respiratory depression since they may produce convulsions under allergic conditions.

The serious respiratory reactions consist of bronchial asthma, laryngeal edema and pulmonary edema. An asthmatic attack is most effectively treated by subcutaneously administered epinephrine, followed by intravenous aminophylline if symptoms persist. If mild symptoms continue, an antihistaminic drug should be given intramuscularly. In the event that severe symptoms persist or status asthmaticus develops, give solu-cortef (100 mg. intravenously). Laryngeal edema should be promptly treated with oxygen and small intravenous doses of epinephrine and an antihistamine. If the above measures fail, an immediate tracheostomy is indicated. As a temporary measure only, adequate oxygen may be supplied by giving 100 per cent oxygen through a 15-gauge needle inserted between the tracheal rings. Pulmonary edema due to an allergic response, and not to acute cardiac failure, should be treated with oxygen, adrenaline, demerol and solu-cortef.

The authors briefly discuss the pharmacology of the several classes of drugs used in the treatment of allergic reactions and present a useful treatment chart which is posted on their own emergency kit.—*Edward B. Best, M.D.*

Beck, J. Swanson. Acute radiation nephritis in childhood. *Brit. M. J.*, Aug. *23*, 1958, 2, 489–490. (From: University and Western Infirmary, Glasgow, Scotland.)

This is a report of a child two and one-half years old found to have a large firm mass in the left side of the abdomen. Surgically this proved to be a Wilms's tumor and was excised. Postoperatively, the

patient received radiation therapy with a specified 3,250 r being given to the left renal area over a period of four weeks. Nine months later, she was found to have a mass in the right renal area and this was treated with 3,000 r over a period of three weeks with the disappearance of the mass.

Thirteen months after the surgery she developed marked palor, ankle edema and face edema with albuminuria, hematuria and granular and hyaline casts. The blood urea nitrogen was 140 mg. per 100 milliliters and the Hb 6.2 gm. per 100 milliliters. There was marked anisocytosis, polychromasia and poikilocytosis.

The patient's condition deteriorated rapidly with associated hypertension and increasing blood urea nitrogen and she died six days following the onset of the symptoms.

Histopathologically the glomeruli showed fibrinoid and hemorrhagic necrotic changes with severe fibrinoid necrosis in many of the arterioles and some of the interlobular arteries. These findings are described as characteristic of acute radiation nephritis.

Radiation therapy rather than surgery was done because the patient had only one remaining kidney with evidence of metastasis. Associated with the renal changes was severe acute hemolytic anemia.

Similar renal and hematologic changes have been described previously in association with the azotemia of acute renal disease but, according to the authors, this is the first case reported with this association following radiation therapy.—*Stephen Bruny, M.D.*

Maluf, N. S. R. Internal diameter of renal artery and renal function. *Surg., Gynec. & Obst.*, Oct., 1958, *107*, 415–428. (From: The Section of Urology, Department of Surgery, Baylor University College of Medicine, the Veterans Administration Hospital, Houston, Texas, and the Kaiser Foundation Hospital, Los Angeles, Calif.)

This study is an attempt to analyze the possible relationship between the caliber of the main renal arteries and the magnitude of renal function. Such a relationship has been suggested previously by several observers. The author has studied the results of a few hundred aortographies while on the full time urologic service of three institutions. One of the values of translumbar aortography is giving qualitative information about extant or potential renal function.

It is noted that the internal diameter of the artery to a healthy hypertrophied kidney in a youngish adult is roughtly 22 per cent greater than that of the artery going to one kidney of a normal pair, and that the effective renal blood flow to such kidneys is about double that for one kidney of a normal pair. As relative standards, the diameters of splenic and hepatic arteries were also measured. In the young adult with two normal kidneys the renal artery is characteristically wider than the splenic. The hepatic artery is nearly identical in caliber to the splenic.

In patients with congenital polycystic kidneys, all were moderately hypertensive and all had renal arteries which were remarkably narrow. The renal arteries were narrow also with reference to the splenic and hepatic arteries. Acute hydronephrosis and intermittent hydronephrosis are not associated with narrowing of the corresponding renal artery, provided renal function has not been markedly reduced. Prolonged hydronephrosis is associated with marked narrowing of the internal diameter of the renal artery. Such narrowing of the internal diameter of a renal artery seems to indicate irreversible renal damage. It is also stated that a narrow renal artery is always indicative of reduced renal function, but an artery of normal caliber is not necessarily demonstrative of normal function. Two illustrations of the latter conclusion are cited. In one instance the renal artery to a nonfunctioning multicystic kidney in a sixty-eight year old man was of almost normal caliber by translumbar aortography. The lumen of this artery was almost filled with a cylinder of a cheesy plaque, through and around which blood obviously flowed. The plaque was radiolucent and not evident in the arteriogram. The second illustration was the observation that adenocarcinoma of the kidney is not infrequently accompanied by appreciable enlargement of the corresponding renal artery.

Assistance in renal evaluation should be obtained from the intensity of the instantaneous nephrogram. The intensity of the renal shadow immediately after intra-aortic injection is compared with that in the scout roentgenogram taken before the injection. When the renal artery is narrow and there is no instantaneous nephrogram, renal atrophy is complete, or practically so. The instantaneous nephrogram is probably due to uptake of the iodide by the tubule cells rather than to its concentration in the lumen by tubular reabsorption of water and tubular secretion of iodide. When the renal parenchyma is normal, the nephrogram is most intense very briefly after the injection and then rapidly falls off in intensity.

Detailed tables, reproductions of roentgenograms, and photographs of specimens and microscopic sections are included.—*D. S. Kellogg, M.D.*

Ribaudo, Charles A. Addison's disease and diabetes insipidus; report of a case secondary to metastatic bronchogenic carcinoma ten years after pneumonectomy. *A.M.A. Arch. Int. Med.*, Sept., 1958, *102*, 478–483. (Address: 159 E. 49th St., New York 17, N. Y.)

This is an interesting case report of a fifty-six year old male who had apparently been cured of a bronchogenic carcinoma ten years previously. He returned with complaints of cough, severe abdominal pain, excessive thirst and urinary frequency. Sub-

sequently he was found to be hypotensive and laboratory studies demonstrated adrenal insufficiency. This was felt to be probably due to metastatic carcinoma. He improved on steroid therapy, but the polydipsia and polyuria continued.

About one month later he complained of diplopia and skull roentgenograms showed destruction of the posterior clinoids and dorsum sellae. Chest roentgenograms at this time demonstrated enlargement of the hilus of the remaining lung.

His condition deteriorated rapidly and autopsy revealed an epidermoid lung tumor with widespread metastases and destruction of the pituitary and both adrenal glands.

The probability that this represented a new carcinoma arising ten years following the previous pneumonectomy is discussed.—*George L. Sackett, Jr., M.D.*

Handel, Jack, and Schwartz, Solomon. Value of the prone position for filling the obstructed ureter in the presence of hydronephrosis. *Radiology*, July, 1958, *71*, 102–103. (From: The Department of Radiology, Jewish Hospital of Brooklyn, Brooklyn, N. Y.)

The prone position is sometimes of value in the urographic demonstration of the obstructed ureter and the site of the obstructive mechanism in the presence of a functioning hydronephrotic kidney. In the normal supine position the proximal ureter runs an up-hill course. As the hydronephrosis progresses, the ureteropelvic junction is rotated more anteriorly in relation to the calyces, and in the supine position comes to lie above them with the flow of urine being against the flow of gravity. Also, the active ejection of urine into the ureter by the renal pelvis is diminished and urinary propulsion is due primarily to the force of excretion. With the patient in the prone position, the relationships of the calyces and the ureteropelvic junction are reversed; the proximal ureter runs a down-hill course, and the force of gravity makes up for the deficit in motor function. The opaque medium which has a higher specific gravity than urine also tends to gravitate more toward the ureteropelvic junction in this position, minimizing the dilution of the medium which occurs in the supine position.—*W. H. Jarvis, Jr., M.D.*

Sichel, D., and Blum, E. Radiographie et tomographie de la prostate. (Radiography and tomography of the prostate.) *J. de radiol., d'électrol. et de méd. nucléaire*, Aug.–Sept., 1958, *39*, 487–493. (From: Clinique chirurgicale B and Service central de Radiologie des Hospices civils de Strasbourg, Strasbourg, France.)

After summarizing the merits of intravenous urography, urethrography and cystography, the authors describe a simple method of air cystography or pneumocystography in the anteroposterior or slightly sitting position, followed by laminagraphy beginning with slices 5 cm. posterior to the anterior wall of the abdomen. Because of the simplicity of this technique, they think that such a study should be made routine, especially in cases where there is doubt as to the diagnosis of the prostatic, vesical or urethral pathology. About 100–200 cc. of air is sufficient to get a good pneumocystogram.

In simple adenoma, the volume, contour and form of the prostate are clearly visualized and a homogeneous density is obtained. In cancer, various images are seen: dome-like elevation as in benign hypertrophy, elevation of the vesical floor with an irregular contour and with density of prostate more pronounced than noted in adenoma. True endovesical proliferations, resembling "flakes of snow" can sometimes be demonstrated, indicating invasion of the floor of the bladder.—*Jirair N. Sarian, M.D.*

Kellock, Ian A., and Gallagher, Niall. Metastatic carcinoma of the prostate and bleeding. *Brit. M. J.*, Aug. 23, 1958, *2*, 487–489. (From: Withington Hospital, Manchester, England.)

The association of prostatic carcinoma and fibrinolysis has been previously described with the possibility being raised that the prostatic cancer might be the source of the enzyme responsible for the dissolution of the blood clot. Fibrinolysis and hypofibrinogenemia have also been seen in association with carcinoma of the head of the pancreas.

Metastatic carcinoma of the prostate and bleeding is an interesting problem in that the bleeding can certainly be dangerous and may be due to fibrinolysis and fibrinogenolysis or to the more frequent finding of thrombocytopenia secondary to involvement of the bone marrow. The bleeding sites are usually in the nose and in the urinary and gastrointestinal tracts and occasionally in the skin. The platelet count may be depressed but the hemorrhagic manifestations in association with fibrinolysis occur despite the presence of a normal level of platelets.

The authors report a patient with metastatic carcinoma of the prostate and fibrinolysis, hypofibrinogenemia, hypoprothrombinemia and thrombocytopenia, who responded to stilbestrol therapy. The patient, sixty-eight years old, entered the hospital after having passed about one and one-half pints of bright red blood per rectum. He was found with many ecchymoses and purpuric areas over the limbs and trunk. He had several severe rectal hemorrhages during the first few days after admission and required transfusion of 4 pints of blood.

Roentgenographic examination showed osteoblastic metastases in the right side of the pelvis and in the lumbar vertebrae.

The patient had anemia and the blood smear showed macrocytes, occasional megaloblasts and 24

nucleated red blood cells per 100 leukocytes. The blood clot in the test tube was found to form in normal time but gradually lysed. By placing a standard fibrin clot washed free of thrombin in the patient's plasma and in a control plasma, the fibrin clot was completely lysed in four hours in the patient's plasma and was intact up to forty-eight hours in the control. The prothrombin time was 70 per cent of normal. The bone marrow was not unusual but after several examinations showed several groups of neoplastic cells. The patient was treated with vitamin B_{12} and stilbestrol with a marked improvement in the fibrinogen levels, disappearance of fibrinolysis, improvement in the prothrombin time and an increase in the number of platelets.

Another patient, sixty-six years old, was also seen with multiple spontaneous ecchymoses, purpura and melena. He was not found to have fibrinolysis but was shown to have metastatic deposits in the bones. He had a prolonged prothrombin time and the highest platelet count was 22,000 per cubic millimeter.

It has been shown that cases of metastatic carcinoma of the prostate with fibrinolysis may have normal platelet counts or slight reduction. If the platelets are normal the cause of bleeding is due to fibrinolysis with or without hypofibrinogenemia. When the platelets are reduced, the bleeding tendency may be due to thrombocytopenia. In the first case the hemorrhagic manifestations were most probably due to fibrinolysis; in the second case to thrombocytopenia.

It is of interest that following estrogen therapy the symptoms and signs in the first patient improved. It has been shown by other investigators that the addition of testosterone to a maintenance dose of estrogen caused an increase in the patient's symptoms and serum acid phosphatase level as well as the reappearance of fibrinolysis. It is felt that the acid phosphatase test could not be replaced by that of fibrinolysis, since the latter occurs in only approximately 12 per cent of the patients with metastatic carcinoma of the prostate.—*Stephen Bruny, M.D.*

Nervous System

Tönnis, W., Friedmann, G., and Nittner, K. Zur röntgenologischen Diagnose und Differentialdiagnose der intraspinalen Tumoren (unter Berücksichtigung der klinischen Symptomatologie). (On the roentgenologic diagnosis and differential diagnosis of intraspinal tumors [with consideration of the clinical symptomatology].) *Fortschr. a. d. Geb. d. Röntgenstrahlen u. d. Nuklearmedizin*, March, 1958, *88*, 288–301. (Address: G. Friedmann, Röntgeninst. R. Janker, Baumschulallee 12–14, Bonn a. Rh., Germany.)

The intrapsinal tumors are divided into: (1) intramedullary and (2) extramedullary, with the latter subdivided into (a) intradural or juxtamedullary and (b) extradural or epidural.

The authors reviewed 204 cases of intraspinal tumors with operative control; three-fifths of these were intradural (juxtamedullary), one-fifth extradural and one-fifth intramedullary. There were 58 neurinomas, 58 meningiomas, 24 gliomas, 14 ependymomas, 18 sarcomas, 22 angiomas, 5 lipomas and 5 epidermoids.

The roentgen findings, except for rare calcification of the tumor, were deformities of the junction of the lamina and vertebral body, increased interpedicular distance and enlargement of the intervertebral foramina. These findings were present in around 10 per cent of intramedullary tumors and 30–50 per cent of observations of the authors are in agreement with the above.

A neurologic examination should precede the roentgenologic examination in order to focus the attention of the radiologist on the segment involved. The roentgen findings are often minimal and could otherwise be overlooked. Among 180 intraspinal tumors where roentgenograms were available, in 55 cases (approximately 30 per cent) positive roentgen findings were present on the plain films.

Gliomas, sarcomas, ependymomas and epidermoids usually produce widening of the interpedicular distance and erosions of the lamina in 3 or more vertebrae, while neurinomas and meningiomas involve only 1 or at the most 2 vertebrae. Meningiomas and neurinomas in particular produce unilateral changes, while the other tumors usually cause bilateral erosions. The smallest lesion producing visible roentgenographic changes was about the size of a cherry.

The roentgen findings are of significance only if a corresponding clinical picture is present and require further examinations (cerebrospinal fluid, myelography).—*Karol E. Matzinger, M.D.*

Fauré, Cl., Lepintre, J., Michel, J. R., and Nasselin, S. Les fistules dermiques congénitales; (à propos de 6 observations). (Congenital dermoid fistulae; report of 6 cases.) *J. de radiol., d'électrol. et de méd. nucléaire*, Aug.–Sept., 1958, *39*, 481–486. (From: Service de Radiologie, Hôpital des Enfants malades and Clinique de chirurgie infantile et orthopédie, Hôpital des Enfants malades, Paris, France.)

Congenital dermoid fistulae are often associated with dermoid cysts and at times with epidermoid cysts. They are hence posterior and median in position.

Spina bifida occulta, enlargement of the vertebral canal, erosion of laminae due to cysts are to be sought in conjunction with fistulae in the lumbosacral region.

In the occipital fistulae, a filling defect or localized

bone erosion at the midpoint of occiput is often noted. Also spina bifida occulta and other congenital malformation of the cervical spine can be observed. Diastematomyelia may be present. At times roentgen signs of intracranial hypertension, such as separation of sutures, digital imprints, erosion of sella turcica, are demonstrated.

Fistulography should not be performed because of serious hazard of infection. Myelography and ventriculography are diagnostic aids in determining the site and size of associated dermoid cysts. Of the 6 cases presented, in 2 the occipital region and in 4 the lumbosacral area was involved.—*Jirair N. Sarian, M.D.*

Levin, Bertram. Neurofibromatosis: Clinical and roentgen manifestations. *Radiology*, July, 1958, *71*, 48–58. (Address: Michael Reese Hospital, Chicago 16, Ill.)

A patient presenting a clinical picture of multiple soft subcutaneous nodules of varying size, associated with *cafe au lait* spots is always quite promptly given the diagnosis of von Recklinghausen's disease or neurofibromatosis. These skin changes, however, are only the most common sign. The author discusses other less common clinical manifestations and gives many illustrations showing the varied roentgenologic findings involving many of the organ systems.

Some of these less common findings include scoliosis, rib erosion, bone overgrowth, orbital defects, optic foramina expansion and posterior mediastinal mass with enlargement of the adjacent neural foramen. The scoliosis is usually the result of destructive changes in the vertebral bodies produced by the multiple neurofibromata of the dorsal roots eroding the adjacent bone. A neurofibroma of an intercostal nerve will frequently produce rib erosion giving a "twisted-ribbon" appearance. Such tumors adjacent to other long bones may cause a "pit or cave" type defect. Increased blood supply to the area of the soft tissue tumors with resultant periosteal hyperemia is thought to be responsible for the bone overgrowth. Orbital defects are usually in the superior portion of the orbit and are associated with pulsating exophthalmos. An optic nerve glioma will produce expansion of the optic foramen, along with visual changes, while involvement of the optic chiasm will usually just cause visual changes.

One of the 11 cases reported had an unexplained anemia and another had precocious sexual maturation. The relationship of these findings in these 2 patients to the presence of neurofibromatosis is not known.—*Donald N. Dysart, M.D.*

Skeletal System

Seaman, Wm. B., and Schwartz, Henry G. Diastematomyelia in adults. *Radiology*, May, 1958, *70*, 692–696. (Address: W. B. Seaman, 622 W. 168th St., New York 32, N. Y.)

Diastematomyelia is a congenital malformation in which a band of fibrous or bony tissue extends dorsoventrally through the spinal canal and between the portions of either a partially duplicated or split spinal cord. Bremer explains this formation as a persistence of an embryonic neuroenteric canal or fistula which extends from the primitive neural groove to the enteric cavity. The fistula usually disappears, but its persistence may be manifested by: increased breadth of the vertebral bodies usually with a decrease in the vertical and anteroposterior measurements; a circular or oval defect extending through the vertebral bodies; development of vertebra with two halves which later fuse to form a median bony or cartilaginous spur projecting into the spinal canal and transfixing the spinal cord; a fibrous cord formed by a remaining fragment of the fistula, attached to an inconspicuous midline cutaneous dimple.

Most of the cases reported in the literature have occurred in children. Herron and Edwards however, in a report of 42 cases, found 11 (26 per cent) in persons sixteen years or older. The clinical picture is atypical and may be acute or chronic. The diagnosis is usually made by the radiologist. The midline bony spicule is the most characteristic finding but is frequently absent and when present is best seen in the frontal projection. Laminagraphy is useful for confirmation of its presence and its intraspinal position. Other associated abnormalities to be looked for include kyphosis, scoliosis, spina bifida, hemivertebra, abnormal fusion of the lamina, failure of segmentation and narrowing of the intervertebral spaces. When none of these findings are present the diagnosis can be made only by the myelographic demonstration of a round or elongated filling defect in the central portion of a widened spinal canal.

Two cases occurring in adults are presented.—*Z. Petrany, M.D.*

LaZerte, Gordon D., and Rapp, Ira H. Pathogenesis of Osgood-Schlatter's disease. *Am. J. Path.*, July–Aug., 1958, *34*, 803–816. (From: The Departments of Pathology and Orthopedic Surgery of the Charlotte Memorial Hospital, Charlotte, N. C.)

The disease described in 1903, independently, by Osgood and Schlatter was originally considered to result from an avulsion of part of the tibial tuberosity by the indirect trauma of quadriceps muscle contraction. By 1926, the lesion was generally accepted to be in the group of osteochondritis deformans juvenilis, aseptic necrosis of various ossification centers with subsequent fragmentation of the bone. Later reports attempted to implicate micro-organisms as etiologic agents. One investigator suggested simply that the degeneration of the tendon is due to strain near its insertion, with formation of ossicles by metaplasia in tendinous tissue.

The authors studied 9 surgical specimens from

males aged thirteen to seventeen years. At operation, an attempt was made to excise an intact block of tissue including tendon, ossicle, and underlying bone. A defect in the anterior cortical bone of the tibial tuberosity was found in every case. Surrounding the defect, callus was found. In no case was necrosis or suppuration present. The ossicle in the tendon consisted of bone surrounded by callus on its inferior aspect. The epiphyseal plate was not primarily involved in any case.

From these findings, it was concluded that the intratendinous ossicle in Osgood-Schlatter's disease is derived originally from an avulsed fragment of the tibial tuberosity. Later, the ossicle is enlarged by proliferation of callus about it. The cortical defect is gradually filled by scar and callus. This study supports Osgood's original contention that the force of quadriceps contraction on a small portion of incompletely developed bone produces an avulsion fracture. This fracture, however, occurs through the ossification center itself and not through the cartilaginous plate.—*A. H. Hall, M.D.*

Davies, A. G. M. The bone changes of Madura foot; observations on Uganda Africans. *Radiology*, June, 1958, *70*, 841–847. (Address: Mulago Hospital, P. O. Box 351, Kampala, Uganda.)

The author describes the main roentgenographic findings in 21 cases of mycetoma pedis or Madura foot. In the majority of the cases the roentgen signs were sufficiently characteristic either to permit confirmation of a clinical diagnosis or to give a strong hint as to the correct diagnosis when the clinical picture was atypical. Some swelling of the deep soft tissues of the foot was a constant feature and, in some, surface nodules could also be seen.

In the bones, both destructive and productive changes were invariably present. The earliest change was a loss of definition in the cortical margin of the affected bones (usually the tarsals), followed later by erosion of the cortex from without and the formation of crypts representing the mouths of sinuses. A characteristically ragged periosteal reaction was almost always present and it assumed the form of spicules of bone projecting perpendicular to the line of the cortex. The spongiosa of the affected bones appeared denser than normal, showing an amorphous sclerosis with loss of the normal trabecular pattern. Often small round or irregular translucent areas from 3 to 10 mm. across were seen, representing sinuses within the spongiosa. Osteoporosis of the bones distal to those involved was commonly found. With progression, the bones diminished in size and the gaps between them increased—a typical feature in advanced cases. Usually no sequestra were noted.

The differential diagnosis should include septic osteomyelitis, tuberculosis, syphilis, malignant tumors, and coccidioidomycosis.—*Donald N. Dysart, M.D.*

Torrance, Daniel J., Jr. "Negative" bone density in a case of multiple myeloma. *Radiology*, June, 1958, *70*, 864–865. (From: Department of Radiology, The Johns Hopkins Hospital, Baltimore 5, Md.)

A case of extreme demineralization of the lumbar vertebrae in a patient with multiple myeloma is described. The unusual feature of the case is that the vertebral bodies were demineralized to an extent sufficient to make them less dense roentgenographically than the intervertebral disks and the surrounding soft tissues.

The findings in this case support the idea that much of the osteoporosis in multiple myeloma may not be associated with marrow replacement by myeloma cells. On physical grounds, the radiolucency appears to be most readily explained on the basis that the marrow cavity was almost entirely filled with fat.—*Arno W. Sommer, M.D.*

Busy, J., Lote, J., and Pallardy, G. Étude radiologique des localisations osseuses de la maladie de Hodgkin. (Radiologic study of the osseous localizations of Hodgkin's disease.) *J. de radiol., d'électrol. et de méd. nucléaire*, May, 1958, *39*, 239–247. (From: Service Central d'Electroradiologie de l'Hôpital Broussais, Paris, France.)

Recently the authors have had occasion to observe, treat and follow up a number of cases of Hodgkin's disease, several of which had bone involvement.

Several problems came up for consideration of which the following are noteworthy: the incidence of bone involvement, its nature, extent and course, and the differential diagnosis. In a series of 100 patients, 17 had osseous lesions, which is lower than in other reports. In a series reported in the literature and reviewed by the authors, in 300 cases the involvement of bone and distribution was as follows: lumbar spine 36 per cent; ribs 12 per cent; pelvis 12 per cent; dorsal spine 10 per cent; femur 7 per cent; sternum 6 per cent; sacrum 5 per cent; scapula 4 per cent; tibia 2 per cent; skull 2 per cent; humerus 2 per cent; and forearm 2 per cent.

The bone changes noted are: (1) areas of decreased density; (2) areas of increased density; (3) a combination of both; (4) bone erosion; and (5) periosteal proliferation.

Treatment may consist of radiation therapy or chemotherapy.

As a result of careful follow-up and evaluation of their cases through a three to five year period, the authors do not feel that the occurrence of osseous involvement in Hodgkin's disease constitutes a serious

complication or is an indication of the gravity of the disease.

Reproductions of 32 roentgenograms and illustrations accompany this article.—*William H. Shehadi, M.D.*

Meschan, Isadore, and Farrer-Meschan, R. M. F. Important aspects in the roentgen study of the normal lumbosacral spine. *Radiology*, May, 1958, *70*, 637–648. (From: Bowman Gray School of Medicine, Winston-Salem 7, N. C.)

Too often the spine is considered roentgenographically as a static organ, and not enough attention is directed toward its functional aspects. It is the functional aspect which is usually of greater significance; static structural deformities which may be noted are secondary. Cineroentgenography offers a new approach to the study of function, but the spine can be studied in static roentgenograms in various positions so that much information can be derived regarding spinal function. This can be accomplished by obtaining roentgenograms in the following manner: (a) in the lateral projection with the patient standing erect, in acute flexion and in hyperextension; and (b) in the anteroposterior projection with the patient bending to the left and then to the right. Motion which occurs in relation to the intervertebral disks and that which occurs in the region of the intervertebral synovial joints is studied.

Careful examination will permit detection of relative fixation of a position of the spine, slipping forward of a vertebral body with respect to adjoining vertebral bodies, and "posterior or reverse spondylolisthesis." True backward displacement does occur. Several causes may produce this abnormality: (a) degenerative processes in intervertebral disks; (b) disease processes particularly affecting intervertebral disks and adjoining bone, such as tuberculosis, syphilis, and primary or secondary bone tumors; (c) trauma; and (d) congenital abnormalities.

The apophyseal joints are subject to all of the diseases which affect synovial joints, including the rheumatoid as well as the hypertrophic arthritides. The gliding movements of these joints are best studied in lateral views of the cervical spine and in oblique views of the lumbar spine. A number of other views, in various degrees of obliquity, may be required.—*A. W. Sommer, M.D.*

Ghormley, Ralph K. An etiologic study of back pain. *Radiology*, May, 1958, *70*, 649–653. (From: Mayo Clinic and Mayo Foundation, Rochester, Minn.)

A group of 2,000 patients with pain in the lower part of the back or sciatica as one of their major symptoms has been studied regarding the etiology of the pain.

Slightly more than 25 per cent (511 cases) were diagnosed as having osteoarthritis which is usually the result of wear and tear, hard usage, and injury, and frequently causes the patients little or no difficulty as long as they do not indulge in hard work or other forms of activity which may provoke local irritation around the vertebrae and thus incite pain. Many in this group had other conditions which might have contributed to their symptoms.

About 22 per cent of the series (445 cases) were suspected of having a protruded intervertebral disk. Of these, 161 were operated upon, and a protruded disk was removed in 147. Spinal fusion was performed in some of the operated cases. The remainder of the patients were treated conservatively, including those few who refused surgery. Approximately 73 per cent of the patients suspected of having a protruded intervertebral disk (324 cases) also had sciatic pain at the time of examination.

Backache which is brought on by activity and is relieved by rest was found in 8 per cent of the group (160 cases) and was attributed to some mechanical fault or static disturbance such as ligamentous damage and degeneration of intervertebral disks, although they may not be demonstrated roentgenographically.

Rheumatoid spondylitis was diagnosed in 6.5 per cent (131 cases). Roentgenographic changes are often late manifestations of the disease, and the diagnosis in early cases, in which sciatic pain is the first manifestation of the disease in about 10 per cent of the cases, must be based on clinical symptoms and physical findings.

Many other entities including coccygodynia, previous trauma, spondylolisthesis and spondylolysis, tuberculous spondylitis, osteoporosis, scoliosis, fibrositis, primary and secondary neoplasms, etc., each accounted for less than 3 per cent of the cases.

There still remained a group of 19 per cent (384 cases) in which the diagnosis was indeterminate.—*Walter H. Jarvis, Jr., M.D.*

Simril, Wayne A. Consideration of pre-existing conditions, congenital and acquired, in the preplacement spine examination. *Radiology*, May, 1958, *70*, 654–660. (From: The Department of Radiology, Washington University School of Medicine, St. Louis, Mo.)

The author discusses the accurate identification of congenital and acquired abnormalities of the spine and their significance to the worker, the industrial physician, and the personnel director. A review of the literature showed that there is a wide range of opinion regarding the significance of most of the abnormalities and anomalies. An adequate pre-employment roentgen study of the lumbar spine should include anteroposterior, lateral and both posterior oblique views. Abnormalities discovered by this procedure will fall into three major groups: (a) con-

ditions secondary to disease, either acute or degenerative; (b) conditions secondary to trauma; (c) congenital anomalies.

Conditions of major importance, often the cause of pain and instability, include hemivertebrae, congenital scoliosis secondary to a tilt of the fifth lumbar vertebra, neural arch defects with spondyloschisis or spondylolisthesis, and unilateral sacralization or lumbarization. These abnormalities are not compatible with good function in a man expected to do heavy labor. Entities of less clinical significance include: accessory ossicles, unfused epiphyses, spina bifida occulta, sacral hiatus canalis, complete or partial failure of segmentation in the mid or upper spine, bilateral sacralization, ossified ligaments, absence or abnormalities of the spinous and transverse processes and "kissing" spinous processes.

Lordosis, angulation at the lumbosacral junction and healed or asymptomatic fractures should be evaluated clinically. The examiner must be careful not to confuse congenital anomalies with traumatic changes. He should also be completely impartial in his evaluation of the films and not identify himself with either the worker or employer in order to be of greatest service to both.—*Donald N. Dysart, M.D.*

Moreton, Robert D., Winston, John R., and Bibby, Douglas E. Value of preplacement examination of the lumbar spine. *Radiology*, May, 1958, *70*, 661–665. (Address: R. D. Moreton, 1217 W. Cannon St., Fort Worth, Texas.)

The preplacement roentgen examination of the lumbosacral spine is an important part of the evaluation of a prospective employee in determining the desirability of hiring this person and in his job placement. This is so because the low back has been found by experience to be the location of the greatest number of back injuries, the "industrial backs," which have been increasing in the recent past. This examination also ascertains the presence or absence of preexisting conditions which may predispose to back injuries, and helps to place the prospective employee in a job which, it is felt, he can adequately handle without undue danger to himself or the public.

The authors report on their findings in a group of 13,000 men. Of these, 20.5 per cent were found to have abnormalities which placed them in the Class v group which consists of abnormalities often associated with clinical back complaints. Of this group 18.2 per cent were found to have conditions which had definitely caused prolonged loss of time and medicolegal problems. The findings in 150 instances of back complaints which were prepared for litigation were also evaluated. In 122, or 81 per cent, low back pain was the main complaint. Thirty-seven of these 122 lumbar spines were reported as being essentially normal and fell in Class I, II, and III which are backs with no abnormalities or with abnormalities not, or rarely, associated with clinical back complaints. Eighty-one, or 66 per cent, of these 122 lumbar spines would have been placed in Class v. Settlements in the group of 37 men were for the most part $10,000 or less and in no case more than $25,000. In the 81 men in Class v, settlements ranged up to a high of $66,000.

Conditions found among these 13,000 men which were the most significant in causing lost time and medicolegal problems consisted of: marked narrowing of the lumbosacral joint space, isthmus (pars interarticularis) defects, fractured vertebral bodies, fractured transverse processes, sacralization with false joint, spondylolisthesis, hypertrophic changes (marked), lipiodol in spinal canal, evidence of previous surgery, and scoliosis (deviation more than 10 mm.). The authors also state that even though the preplacement examination is an excellent method of excluding certain defects of the lumboscaral spine, it will not exclude disk problems or prevent fractures when major trauma is sustained.—*Donald N. Dysart, M.D.*

Stack, James K. Role of the radiologist in management of low back pain. *Radiology*, May, 1958, *70*, 666–671. (Address: 700 N. Michigan Ave., Chicago 11, Ill.)

The role of the radiologist in the management of low back pain is necessarily a passive one. The actual taking of roentgenograms helps many patients in an active way, in that they are a source of satisfaction and confidence to the patient who may have been examined rather hurriedly by the clinician. The radiologist can also be of help by the type of report he gives. In a report to a clinician who is not well versed in all the ramifications of low back pain, emphasis or the lack of emphasis on certain positive and on certain negative findings may be of great value in his handling and treatment of the patient. Reports on an orthopedist's patients obviously need not be extremely detailed as the orthopedist himself always examines the films and is particularly cognizant of the significance of various findings and their relationship to low back pain.

The importance of the lumbar facets is stressed as they are frequently the source of low back complaints but are often forgotten or ignored by the radiologist in his evaluation of the roentgenograms. These facets are the true joints of the spine, and just like other body joints, contain subchondral bone which is capable of reaction, distress, degenerative disease and other inflammatory conditions. They have hyaline cartilage, synovial membrane, joint fluid, supporting ligaments, and are subject to the same traumatic and degenerative ills as any other weight-bearing joint. Indications for myelography are felt by the author and his group to be few and far between, especially in the absence of objective neurologic findings.—*Donald N. Dysart, M.D.*

Fontaine, René, Muller, Jean-Nicolas, and Warter, Pierre. Les hyperplasies osseuses réactionnelles dans la maladie de Lobstein ou ostéopsathyrosis et leur évolution après une thymo-parathyroidectomie; à propos d'un cas personnel. (Hyperplasia reaction of bone in Lobstein's disease or osteopsathyrosis; its evolution following a thymo-parathyroidectomy; report of a case.) *Presse méd.*, Oct. 1, 1958, *66*, 1499–1501. (From: Clinique chirurgicale A, Strasbourg, France.)

The authors report a case of Lobstein's disease (osteopsathyrosis or osteogenesis imperfecta).

Since birth, the child had many recurrent fractures following minimal trauma with exuberant callus formations as if the organism had tried to compensate the poor quality of the osseous matrix by voluminous reparative osteogenesis. Some posttraumatic deformities of the long bone were also discovered: shortening and incurvation of some of the bones, some diaphyseal exostoses, not of the enchondromatous origin, but of the synthetic type. This latter type is thought to result from ossification of subperiosteal hemorrhage probably following small periosteal lacerations or cortical fissures. When first seen by the authors, the child was six years of age. On repeated tests, a hypercalcemia around 12 mg. was disclosed for which a thymo-parathyroidectomy was performed. The thymus was considered normal for the patient's age and a small portion of it was left in place.

Two years later, at the age of eight, the child was seen with no history of new fractures, and the calcemia was found normal (9.8 mg.). The child was not seen again until the age of sixteen. At that time, it was learned that the patient at the age of ten had consulted for a mass located on the posterior aspect of the right lower femur. The mass had been noted in April 1948. Four months later, in July 1948, the mass had considerably enlarged. It was hard, of osseous consistency, and slightly painful. The roentgenograms taken at that time are reproduced and they show a typical parosteal osteosarcoma involving the posterior aspect of the diaphyso-metaphyseal region of the lower femur. In view of these findings a diagnosis of osteosarcoma was made by a radiologist and a surgeon. No biopsy was done and the child was subjected to radiation therapy of unknown dosage.

Roentgenograms of the same femur, taken by the authors six years later, when the child was sixteen, show a quiet and well ossified periosteal formation appearing as a large sessile exostosis. In the authors' opinion, this formation represents an ossified subperiosteal hematoma which probably matured rapidly under radiation treatment.

The calcemia was checked again and found normal with no fractures sustained by the child since his thymo-parathyroidectomy. Other similar osteosarcoma-like hematomas have been reported by Backer and by Debré.

In conclusion, the authors stress the frequent occurrence of hypertrophic callus formations in osteogenesis imperfecta, giving rise to exostoses and sometimes to voluminous osseous neoformations mistaken for osteosarcoma. They believe that the child has been helped by a thymo-parathyroidectomy, in view of the fact that no fractures have re-occurred since his operation. Hypercalcemia has not been reported previously in osteogenesis imperfecta and should be repeatedly looked for.—*H. P. Lévesque, M.D.*

Johnson, Philip M., and McClure, James G. Observations on massive osteolysis; a review of the literature and report of a case. *Radiology*, July, 1958, *71*, 28–42. (Address: P. M. Johnson, School of Medicine, University of North Carolina, Chapel Hill, N. C.)

Massive osteolysis is a rare chronic disease which begins insidiously and is characterized by a progressive regional loss of bone with resultant deformity. The majority of patients are children or young adults. There is no evidence of genetic transmission or sex predilection. No disturbance of calcium-phosphorus metabolism has been discovered, and there are no stigmata of systemic or endocrine disease. Osteolysis may originate in virtually any osseous structure, but the disease exhibits a propensity for involvement of the shoulder girdle and the pelvis. Multiple contiguous bones are usually involved. The course is unpredictable. Spontaneous arrest may be expected in a few years but the disease may progress rapidly to a fatal termination. Reossification apparently does not occur after spontaneous arrest, but it has been reported after radiation-induced arrest.

Intraosseous angiomas form a well recognized entity which generally has no clinical significance. Massive osteolysis represents an extraordinary form or variant of angiomatosis, undistinguishable histologically from the benign form. In its early stages the disease cannot be distinguished roentgenographically from localized nonsclerosing osteolysis due to other causes. As the disease progresses a roentgenologic diagnosis can be made on the basis of purely osteolytic destruction of multiple contiguous bones in a child or a young adult. Confirmation of the diagnosis prior to biopsy may be obtained by methods which opacify the angioma.

A total of 32 cases of massive osteolysis have been discovered; 12 have been histologically confirmed, including the case reported by the authors.—*Arno W. Sommer, M.D.*

Hambach, Rudolf, Pujman, Jaroslav, and Maly, Vladimír. Massive osteolysis due to hemangiomatosis; report of a case of Gor-

ham's disease with autopsy. *Radiology*, July, 1958, *71*, 43–47. (Address: R. Hambach, State Hospital, Jihlava, Czechoslovakia.)

Massive osteolysis (acute spontaneous absorption of bone, phantom bone, disappearing bone) is a rare disease, only a few cases having been described in detail. Gorham, Wright, Shultz and Maxon (1954) and Gorham and Stout (1955) in previous reports on 10 patients with this condition have noted that the progressive osteolysis appears to be always associated with an angiomatosis of blood vessels, and sometimes of lymph channels.

A case of massive osteolysis leading to death in fourteen months is reported. A sixteen-year-old boy was admitted to the hospital on July 25, 1955, complaining of sudden onset of pain in his right shoulder and inability to move his right arm. There was no history of previous injury. Roentgenographic examination two days after admission showed absence of a major protion of the right scapula and outer third of the right clavicle, with osteoporotic changes in the remaining bone. Laboratory tests gave normal values except for a slightly increased alkaline phosphatase. A biopsy from the residual part of the right scapula resembled an ordinary hemangioma of bone without signs of malignancy. Clinically, however, the course of the disease was that of a fairly rapidly progressing tumor, finally destroying the entire right scapula and clavicle, and involving the upper right humerus, and eventually the body of the fourth cervical vertebra. The vascular nature of the tumor was demonstrated by angiography, injecting the radiopaque material directly into the region of the scapula, which revealed an angiomatous system having the outline and general appearance of the right scapula. A deformity appeared in the right scapular region, resembling that of a dislocation, and a large cutaneous hemangioma developed in the lateral part of the right interscapular area. Histologic sections showed a cutaneous sclerosing type of hemangioma. Deep roentgen therapy was employed without any signs of benefit. The patient expired September 22, 1956, fourteen months after the onset of his first symptoms.

At autopsy the right scapular region and the proximal part of the right upper extremity were found to be edematous. The bodies of the third and fourth cervical vertebrae in their right medial portions and the bone tissue of the right scapula and the right clavicle were replaced by a soft grayish-red tissue having the appearance of a mass of convoluted blood vessels. The head of the right humerus had undergone similar transformation, and there was a fracture in the region of the anatomic neck. The lower portion of the humerus had the gross aspect of worm-eaten wood. Histologically, the lesions were typical hemangiomas. The cause of death was the total collapse of both lungs produced by massive hemorrhagic exudate associated with bronchopneumonia.

This case lends additional support to the conclusions drawn by Gorham and Stout that hemangiomatosis is regularly associated with massive absorption of bone, and may well be the cause of it, although the actual mechanism involved is still unknown.—*Walter H. Jarvis, Jr., M.D.*

Howland, Willard J., Jr., Pugh, David G., and Sprague, Randall G. Roentgenologic changes of the skeletal system in Cushing's syndrome. *Radiology*, July, 1958, *71*, 69–78. (Address: W. J. Howland, Jr., The Mayo Clinic, Rochester, Minn.)

The present report is based on a study of 141 patients with the clinical diagnosis of Cushing's syndrome established at the Mayo Clinic during the years 1947–1955. Since compressed vertebral bodies were the subject of special interest, only the 69 cases in which roentgenograms of the spinal column in lateral views were available were subjected to complete analysis. The diagnosis and grading of osteoporosis in this study was based on the degree of alteration of trabecular structure, diminution of density allowing for technical factors, and in case of the spinal column, ballooning of the intervertebral disks. Of the 43 cases in which there were roentgenograms of the skull available, 25 patients showed osteoporosis manifested by diffuse decalcification which had certain similarities to that seen in hyperparathyroidism. The other 18 showed localized areas of hypomineralization which consisted of irregular zones of rarefaction separated by bone of relatively normal appearance, resembling osteolytic metastatic lesions, so much so that biopsy was performed in one case, and showed only osteoporotic bone. The lamina dura could be identified in all 6 cases with complete oral roentgenograms. Post-treatment skull roentgenograms of 11 patients in clinical remission for more than six months showed varying degrees of recalcification in 8 cases. Seven of the 43 skull roentgenograms displayed enlargement and erosion of the sella. Other instances of decalcification of the sella were attributed to cranial osteoporosis. Thoracic roentgenograms of 55 patients showed osteoporosis of the ribs of varying degrees in all but one. Rib fractures were frequent and the callus was unusually rare. All but 2 of 68 roentgenograms of the pelvis showed osteoporosis, usually of about the same degree as that in the lumbar portion of the spinal column. Fractures of the pubic or ischial rami were present in 6 cases, all of which showed heavy callus formation and all were associated with moderate or severe osteoporosis. None of these patients gave a history of pain in the pelvic region. Roentgenograms of the extremities of 11 patients showed varying degrees of osteoporosis in 5 cases. One patient had a pathologic fracture of the right tibia, and there was one instance of Kienböck's osteochondrosis of the right semilunar bone.

An analysis of the spinal roentgenograms of the 69 patients revealed marginal condensation of the vertebral bodies in 29 of the entire series of 69 cases (42 per cent) which gives an incidence of 53 per cent in the 55 cases in which moderate or severe osteoporosis was present, since compression and condensation occurred only when the osteoporosis was more than minimal. The lower thoracic and upper lumbar regions were affected most frequently, and occurred in both regions in 11 patients. In no instance was there a condensation or compression fracture in the cervical part of the spinal column. The condensation usually occurred along the upper margins of the vertebrae, but occasionally it was seen along the lower margins. Although it ordinarily was associated with readily apparent compression of the vertebral body, in a few instances this was minimal and its recognition was difficult. Compression fractures occurred in 33 of the 69 patients, which included all 29 who had condensation of one or more vertebral bodies, an incidence of 88 per cent, and all but 5 complained of pain in the back. Post-treatment (more than six months) spinal roentgenograms of 19 patients were available. All but one of this group showed clinical remission of the signs and symptoms of Cushing's syndrome. Eight showed a significant decrease in the degree of osteoporosis, but in no instance had it disappeared completely. Of the 8 patients who had previously showed condensation, in 2 it had not changed, it had decreased in 3, and had disappeared completely in the other 3. It also appeared that the condensation diminished or disappeared before any change in the osteoporosis was demonstrable roentgenographically.

As a control, the records and roentgenograms of 50 patients with severe generalized osteoporosis due to other causes were reviewed. In none of these was there clinical evidence of malignancy, a history of administration of cortisone or corticotropin (ACTH), or clinical signs of Cushing's syndrome. In the control group there was no unusual appearance of osteoporosis in the skull in the 5 cases available. The ribs showed severe osteoporosis in all of the 40 available cases and there were only 2 patients in whom rib fractures were seen, both of whom gave histories of trauma and thoracic pain, and the callus appeared normal. There were no pelvic fractures demonstrated in any of the 46 available cases, all of which showed severe osteoporosis. There were 5 patients with recent or old fractures of the distal extremities, all associated with severe osteoporosis. Spinal roentgenograms of the 50 control patients revealed compression fractures of one or more vertebral bodies, chiefly in the lower thoracic and upper lumbar regions, in 46. All but 2 gave histories of present or past pain in the back. Condensation of vertebral bodies was seen in a single instance—a seventy-five year old woman with senile osteoporosis, who had minimal condensation of 2 lumbar vertebral bodies.

A previously published article by other authors showed the marginal condensation to be due to the impaction of slender trabeculae in this area, which then became surrounded by newly formed bone to produce a thicker structure, although the authors did not call attention to this. Previous authors have reported the interference with the healing of the pathologic fractures to be due to the corticosteroids. The callus produced evidently does not give normal strength to the site of the fractures; these fractures are not so painful as fractures normally are, owing to an analgesic effect of the adrenal steroids. For this reason, the part is not splinted as much as it normally would be. Consequently, there is a continued strong stimulus for the production of osteoid. The osteoid becomes calcified and thus is visible roentgenographically. This may be the explanation for the unusually heavy callus about fractures of the ribs and pelvis and the marginal condensation of vertebral bodies.—*Walter H. Jarvis, Jr., M.D.*

Lansche, W. Edward, and Spjut, Harlan J. Chondrosarcoma of the small bones of the hand. *J. Bone & Joint Surg.*, Oct., 1958, *40-A*, 1139–1145. (From: The Department of Orthopaedic Surgery and Surgical Pathology, Washington University School of Medicine, Barnes Hospital, and Barnard Free Skin and Cancer Hospital, St. Louis, Mo.)

Chondrosarcoma of the small bones of the hand is rare. The authors carefully reviewed the literature and found only 8 cases. A ninth case is added in a patient who was recently treated at the Barnes Hospital.

The patient, a white female, fifty-nine years old was first seen nine months previously because of a tender swelling of the dorsum of the left hand. Roentgenograms showed a cystic lesion of the third metacarpal head and scattered areas of mottled lucency in the proximal portion of the metacarpal shaft. The lesion was removed by curettage and the histologic examination was reported as being compatible with an enchondroma. Two months prior to her admission to the Barnes Hospital the swelling of the left hand recurred and became painful. An en bloc amputation of the third finger and metacarpal through the third metacarpocapitate joint was performed. The histologic picture confirmed the preoperative diagnosis of chondrosarcoma. A review of the original material curetted at the first operation was similar and, in retrospect, showed chondrosarcoma.

It is often stated that cartilaginous lesions in the small bones of the hand are benign, while those of the long bones, pelvis, and shoulder girdle are often malignant. Why, if enchondromata are more common in the small bones of the hand and especially in the phalanges, is chondrosarcoma of the small bones of the hand so rare? Does this represent a malignant transformation of a previously benign enchondroma? —*William C. MacCarthy, Jr., M.D.*

Jacobs, Julian E. (Charlotte, N. C.) Observations of neuropathic (Charcot) joints occurring in diabetes mellitus. *J. Bone & Joint Surg.*, Oct., 1958, *40-A*, 1043–1057.

Charcot joints and painless neuropathic ulcers of the lower extremity may occur in diabetes mellitus as well as in tabes dorsalis and syringomyelia. The author adds 3 cases to the 42 reported previously in world literature; one case in which there was a return to normal in the appearance of the roentgenograms of neurotrophic joints in the foot.

Pathologic and roentgenologic findings are similar to those found in the neuropathic arthropathies of syphilis and syringomyelia. It is advised that frequent roentgenograms be taken of the lower extremities of diabetic patients with trophic ulcers, anticipating the possibility of early arthropathy.—*William C. MacCarthy, Jr., M.D.*

Andersen, Prefen Thestrup. Congenital deformities of the knee joint in dislocation of the patella and achondroplasia. *Acta orthop. Scandinav.*, 1958, *28*, 27–50. (From: The University Orthopaedic Clinic, Copenhagen, Denmark.)

An attempt is made to evaluate the etiologic and prognostic significance of the roentgenographic changes in patients with slipping patella and in achondroplasia. To do this, the author classified the roentgen appearance of the knees in 284 patients, dividing the osseous and articular changes into three main groups: (1) primary dysplastic; (2) bone changes due directly to the dislocation; and (3) secondary changes.

I. *Changes in Patellar Shape and Position.* In the tangential views changes in patellar shape were noted and divided into three types: (a) total flattening of the articular surface; (b) comma-shaping: excavation of the lateral articular surface so that it occupies two-thirds of the entire posterior surface, the medial portion becoming convex; and (c) normal.

One hundred and forty-two patients exhibited changes in patellar shape either as the only dysplastic sign or coexisting with dysplastic changes in the femur or tibia. Of these, 11 had acquired dislocation and all had a history of violent initial trauma followed by acute articular symptoms except one whose dislocation was a sequel of poliomyelitis with paresis of the quadriceps femoris.

The level of the patella was estimated according to Blumensaat's criteria (which the author describes). Of 286 patients, 207 had patella alta. No other diseases (poliomyelitis, Schlatter's disease, and spastic lower limb) which may cause patella alta were included in this series. Patella alta entails a disturbance in the equilibrium between the quadriceps and the ligament and hence leads to instability. Isolated patella alta without actual dislocation occurred in only one case and this patient had periodic instability, a sign found to be a typical sequela of high position (Pitzen). Patella alta may also be accompanied by an alteration in shape due to the altered articulation between patella and femur. In the great majority of patients, the condition was bilateral (12 cases unilateral). This was a common dysplastic abnormality being present in 75 per cent of the cases roentgenographed and also may be associated with other dysplastic changes in the knee joint.

In most cases patellar dysplasia is associated with other osseous changes in shape and position. Isolated congenital patellar dysplasia was found in a total of 56 patients, in 51 of whom it was bilateral. The sequelae of patellar dysplasia roentgenographically manifest themselves as incongruence in the femoropatellar joint. The author feels that "the great accumulation of patellar dysplasia in a series of patients with dislocation of the patella must be taken as proof that congenital maldevelopment of the joints predisposes to permanent or intermittent malposition of the joint."

II. *Changes in the Femoral Condyles.* Dislocation of the patella has been attributed to primary developmental anomaly of the lateral femoral condyle by many. Others feel the femoral changes are secondary (fetal rickets, intrauterine trauma, central nervous system abnormalities, and deficient blood supply being given as possible etiologic agents).

The author studied not only the appearance and shape of the lateral femoral condyle but also the shape and depth of the patellar groove. One hundred and fifty-four patients had variations in the height of the lateral in comparison to the medial condyle. Flattening of the patellar groove was seen in 108 cases.

The patellar and condylar changes as well as the variations in their articulation make up a special type of femoropatellar dysplasia. Dysplasia of the lateral femoral condyle and patellar groove were found isolated, like changes in patellar shape, in the group with the most severe initial trauma. These are cases with slight congenital changes, the condition being predominated by the trauma. In these cases condylar dysplasia is considered a cause of the intermittent malposition of the patella.

Total dislocation, the patella resting on the external aspect of the lateral condyle, occurred in 19 cases ranging from one associated with total flattening of the patella, aplasia of the lateral femoral condyle and a flat patellar groove (typical femoropatellar dysplasia) to more transitional varieties.

The predominant majority of patients among those who have congenital predisposition to dislocation had either patellar dysplasia or femoropatellar dysplasia with incongruence of the joint, hence these factors must be an important cause of intermittent dislocation and permanent malposition of the patella.

III. *Tibiofemoral Changes.* Some investigators believe that increased external rotation of the femur rather than aplasia of the lateral femoral condyle is

the primary factor. The author found 7 cases with pronounced rotation. All had marked changes in the knee joint and permanent patellar dislocation. Even though one may hypothesize that less marked rotation may be present in the milder cases, the author's series failed to demonstrate any evidence in this respect.

Others felt that genu valgum associated with a lax capsule was the cause of patellar dislocation. The author found that a pathologic valgus position often coexisted with dislocation or permanent malposition of the patella. These factors, rotation and valgus positions, make up the third dysplastic type in patellar dislocation—the tibiofemoral—encountered in 41 patients.

The author also presents his roentgenographic technique in respect to the number and position of the films used in his series along with several illustrative case reports.—*William C. MacCarty, Jr., M.D.*

Vose, George P. X-ray transmission factor in estimating bone density. *Radiology*, July, 1958, *71*, 96–101. (Address: Nelda Childers Stark Laboratory for Human Nutrition Research, Texas Woman's University, Denton, Texas.)

A method for determining the roentgen-ray transmission factor of bone is described. The device used is similar to that employed for measuring linear roentgen-ray absorption coefficients of elements. A very sharp, collimated, and filtered beam of roentgen rays is made to pass through the bone for which the transmission factor is to be determined. A short metallic tube on the opposite side of the bone conducts the residual primary rays to a radiation detector. The ratio of the initial intensity to the transmitted intensity is determined by comparing the detector readings with the bone in place and, again, without the bone in position. The transmission factor as determined by this method may be used as a criterion of bone density.

Although the number of anatomic positions for bone density measurements is limited, direct readings of roentgen transmission can promote rapid and inexpensive determinations with a high degree of accuracy.—*Arno W. Sommer, M.D.*

Blood and Lymph System

Gensini, Goffredo G. A new intensifying screen-film combination for angiocardiography and other roentgenographic procedures. *Radiology*, July, 1958, *71*, 104–106. (Address: Department of Research and Laboratories, National Jewish Hospital at Denver, Denver 6, Colo.)

A very significant decrease in both the time of exposure and the quantity of radiation employed in roentgenography, particularly in angiocardiograhpic studies, can be obtained by the use of intensifying screens specially designed to provide light emission of the wave length to which the fastest contemporary photographic emulsions are most sensitive. Recent progress in the photographic field has resulted in the development of extremely fast panchromatic emulsions with speeds up to 320 to 2,000 per cent higher than that attainable with the usual emulsions. Since the formation of the image on the roentgenogram is due mainly to the visible light fluorescence from the intensifying screen, it would seem logical to employ a type of screen, the peak emission of which would match the peak spectral sensitivity of these newer emulsions. To test the hypothesis, the author selected 3 types of films and 3 screens, thereby getting 9 screen-film combinations. Of the 3 films used, 2 were the regular roentgen-ray films: Kodak Blue Brand and Royal Blue. The third was the single emulsion Panchromatic Kodak Royal X. The screens used were DuPont-Patterson Par speed, Lightning Special and CB2. Exposure factors, developing and measurement of density of the exposed films were carefully controlled and the results of each combination accurately recorded. It was found that the CB2-Royal X combination had the greatest sensitivity and also had wider latitude and contrast range than any of the other combinations. By controlling the voltage (kv.) and milliampere-seconds (mas.) to get satisfactory densities, up to 50 per cent reduction in radiation exposure to the patient could be obtained.—*Z. Petrany, M.D.*

Gergely, R. The roentgen examination of the lymphatics in man. *Radiology*, July, 1958, *71*, 59–68. (Address: Abel Jenö u. 12, Budapest, XI., Hungary.)

Lymphangiography is a relatively new diagnostic procedure in which the lymph vessels are rendered opaque by the direct injection of small amounts of an organic iodide, after the method of Kinmonth and Taylor.

The normal lymphatics of the lower limb are composed of a superficial and a deep system. The clinically important superficial lymph vessels pass above the aponeurosis of the limb through the connective tissue just beneath the skin and are represented by a medial and a lateral group. The medial superficial lymphatics, 1 to 4 in number, arise from the medial side of the foot and pass upward along the medial side of the tibia following the course of the greater saphenous vein. At about the knee they bifurcate and ascend along the medial side of the thigh to the superficial inguinal lymph nodes. The lateral superficial lymphatics arise from the lateral side of the foot, curve posteriorly around the lower third of the leg and likewise pass upward along the medial side of the thigh to terminate in the superficial inguinal lymph nodes. A typical feature of the nor nal lymph vessels is their small capacity since only about 1 to 4

ml. of contrast medium can be taken up at a single injection, depending on the number of vessels being filled. These vessels are thin, thread-like and wavy with numerous closely-spaced valves which produce a spindle-shaped appearance on the roentgenogram.

Lymphangiography in cases of lymphedema reveals definite changes depending on the type of lesion, its duration, and extent. In general the vessels appear thickened and tortuous with varying diameters. Retrograde filling is not unusual due to valvular destruction or incompetence and the capacity of the system is increased so that it can readily receive 20 to 50 ml. of the medium. The secondary lymphatic changes in cases of chronic venous insufficiency are similar, with tortuosity, irregularity and an increased capacity though not as marked as in lymphedema.

The author concludes that lymphangiography in cases of chronic edema of the extremities will produce information of great diagnostic, prognostic and therapeutic value.—*Edward B. Best, M.D.*

Brasche, H. Ein Beitrag zur Technik der Aortographie. (A contribution to the technique of aortography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen u. d. Nuklearmedizin*, June, 1958, *88*, 669–679. (From: Chirurgische Klinik, Ulm/Donau, Germany.)

Three different approaches are used for aortography according to the planned visualization of the segments of the aorta: (1) the deep lumbar approach at the level of the third lumbar vertebra for visualization of the lower abdominal aorta with bifurcation and the arteries of the lower extremities; (2) the retrograde filling via the femoral artery for filling of all segments of the aorta above the level of L-3; and (3) the visualization of the thoracic aorta via the brachial artery. This method is especially useful for visualization of the isthmus stenosis.

Technically, the thoracic, respectively the lumbar aortography is conducted through a polyethylene tube or catheter, containing a mandrin, introduced either percutaneously or after exposure of the artery. The position of the tube is checked fluoroscopically before removal of the mandrin after which 10 cc. of 76 per cent urografin is injected for a test roentgenogram. Finally, after correction, the full amount is injected.

For the visualization of the lower aortic segments, a so-called Denecke cannule is used. This cannule is 25 cm. long, has a pointed end with an opening on the side of the end portion not at the point. This prevents plugging by tissue particles. Therefore, mandrin is not necessary and the escaping pulsating blood stream indicates that the needle is in the lumen of the aorta. The cannule is introduced through a small incision underneath the free margin of the twelfth rib and from here is advanced toward the third lumbar vertebra. After the body of the vertebra is reached, the cannule is withdrawn for 1–2 cm., the end part lifted, and then advanced slowly in front of the vertebra until the aorta is reached. Before the contrast material is introduced, about 3 cc. of 1 per cent novacaine is injected for prevention of arterial spasm.

Serial roentgenograms are necessary for evaluation. The apparatus of Paessler is employed. Three injections of 20 cc. of 76 per cent urografin are made in sequence for visualization of (a) the abdominal aorta to the bifurcation, (b) the vessels of the thigh and (c) the vessels of the lower leg. Between the contrast material injections, normal saline is blown in. Initially, load anesthesia was used but since October, 1956 the deep aortography (lumbar) was performed in barbiturate anesthesia.

After completion of the procedure, the cannule should be removed very carefully. The lumbar muscles are pressed for three to five minutes against the aorta. This is followed by twenty-four hour complete bed-rest. Special attention must be paid to: (1) urinary excretion; (2) intestinal tract; and (3) bleeding. Ambulatory aortographies are not to be recommended. After previous operations, such as sympatectomies, in that area, two to three weeks should pass.

The following complications were noted in the author's material: (1) escape of spinal fluid, if the dural sac was pierced; (2) filling of the renal arteries, this especially in cases of occlusion of the bifurcation (since only 20 cc. was used, damage was not observed); (3) para-aortic extravasations; and (4) puncture of the vena cava inferior with a resulting cavogram (one case without ill effects).

Eleven illustrations are presented; among them, serial angiograms of the abdominal aorta taken five, eight, and eleven seconds after the injection.—*Nathan Kriss, M.D.*

Bruwer, André J., and Ellis, F. Henry, Jr. A slow injection method of aorto-arteriography. *Surg., Gynec. & Obst.*, Sept., 1958, *107*, 287–293. (From: The Sections of Roentgenology and Surgery, Mayo Clinic, and the Mayo Foundation, Rochester, Minn.)

Because as many as 40 serious complications and 25 deaths have been reported following translumbar aortography, a two stage method for the procedure has been developed at The Mayo Clinic. Xylocaine epidural block with sensory anesthesia up to D-8 is employed. The usual aortic puncture is made at the level of L-1 or D-12 just above the renal arteries and 12–15 cc. of 70 per cent urokon is injected, to obtain roentgenograms of the abdominal aorta and the common iliacs. After viewing this roentgenogram, if the aorta is patent throughout its abdominal course, a second needle is inserted in the aorta below the renal arteries and 50–60 cc. of diluted contrast medium (by diluting 40–50 cc. of 70 per cent urokon in 10–15 cc. of saline) is injected in ten to

fifteen seconds. This allows time for most peripheral vessels to fill.

The technique described permits visualization of all the abdominal aorta and pelvic vessels on one 14×17 inch roentgenogram and of the femoral, popliteal and proximal one-half to the tibial and peroneal arteries on the second 14×17 inch roentgenogram.

No complications were noted after using this method in several hundred cases.—*Frank M. Windrow, M.D.*

Nelson, Sidney W., Molnar, William, Klassen, Karl P., and Ryan, Joseph M. Aortic valvulography and ascending aortography. *Radiology*, May, 1958, *70*, 697–712. (Address: W. Molnar, University Hospital, Columbus, Ohio.)

The difficulty in distinguishing the diastolic murmurs of pulmonary valvular insufficiency and aortic insufficiency led the authors to develop a method of thoracic aortography well suited for the evaluation of aortic valvular function. This differentiation of diastolic murmurs is important in that patients undergoing mitral commissurotomy for mitral stenosis have been noted to receive little or no benefit from the procedure if there is a concomitant aortic valvular insufficiency.

After investigating various methods of injecting contrast media for aortic valvulography, the side-opening, closed-end catheter was found most efficacious as this prevented the false aortic regurgitation that was produced by the injection of contrast media near the valve through open-end catheters. The technique as developed calls for a small skin incision over the right common carotid artery which is then exposed surgically and isolated with 2 cigarette drains. A small incision is made in the artery and a specially constructed 14F tapered silk, closed-end, side-opening catheter is advanced through the incision into the aortic arch under fluoroscopic control. The tip is directed into the ascending aorta and as it approaches the aortic valve area, it exhibits a side-to-side fluttering motion. At this point, 30 cc. of 90 per cent hypaque is injected in two to four seconds with electrically controlled exposures starting simultaneously with the beginning of the injection and continuing for six seconds.

This method was used on patients with mitral stenosis who had diastolic murmurs which could not be definitely localized to the aortic or pulmonary valve by clinical methods. In those patients exhibiting definite evidence of aortic insufficiency on the aortogram, the authors believe mitral commissurotomy is probably contraindicated. With no evidence of aortic insufficiency, the diastolic murmur is ascribed to pulmonary valvular insufficiency (Graham Steell murmur).

This method has also proved useful in the diagnosis of aortic scarring due to syphilis, aortic valve vegetations, pulmonary artery-aortic fistulae, aneurysms of the ascending aorta with their exact points of origin and relation to coronary arteries and great vessels, and the coronary artery circulation itself. In 51 aortographic studies utilizing this procedure, there were 2 complications, only one of which was permanent, a left hemiparesis in a seventy-four year old male.

Accompanying the article are excellent roentgenographic reproductions and drawings which clearly illustrate the described conditions.—*John S. Alexander, M.D.*

Schlicht, Leo. Über das Kymogramm degenerativer Wandprozesse der Iliakalarterie bei lumbaler Aortographie. (Kymogram in degenerative changes of the iliac artery in lumbar aortography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen u. d. Nuklearmedizin*, June, 1958, *88*, 680–684. (Address: L. Schlicht, Laplacestrasse 32, München 27, Germany.)

Kymography was used in the course of 200 lumbar aortographies. The kymographic tracing of the thoracic aorta can be obtained without contrast filling; however, those of the abdominal aorta and of the iliac vessels require contrast opacification.

The usual angiographic studies do not give information about the functional aspects of the wall of the arteries during the flow of blood. The degeneration of the wall with stenosis of the lumen results in a flail-like movement proximal to the narrowing. Weakness of the vessel wall in the lateral plane shows increased pulsatile widening with caterpillar-like contour. The weakening in longitudinal direction causes bowing and elongation of the vessel.

Kymographic cassettes of 24×30 cm. were used with two and one half seconds of travel. Fifteen cc. of 70 per cent contrast material was injected in three seconds, starting one second before the transport of the cassette.—*Nathan Kriss, M.D.*

Molnar, William, Riebel, Frank A., and McCormack, Kenneth R. Splenic vein thrombosis; three cases. *Radiology*, May, 1958, *70*, 684–691. (From: Department of Radiology, Ohio State University, Columbus 10, Ohio.)

Splenic vein thrombosis is rarely diagnosed with certainty prior to surgery or autopsy. In the several large series of splenoportographies reported in the literature since 1952, when the procedure was first introduced, only single instances of thrombosis of the splenic vein have been demonstrated; however, in 1956, 3 cases were diagnosed by percutaneous splenoportography among 36 splenectomies done at Ohio State University Hospital for hematologic conditions.

Thrombosis of the splenic vein may be associated with a variety of lesions, among them compression or invasion of the splenic vein by carcinoma of the pancreas, carcinoma of the stomach and esophagus, or an enlarged lymph node, pressure by benign lesions such as chronic pancreatitis, retrogastric hematoma due to trauma, or large aneurysm of the splenic artery. Thrombosis is a frequent sequel to splenectomy and is occasionally seen after gastrectomy. Certain hematologic conditions like polycythemia, or in very rare instances thrombocythemia, may also cause splenic vein thrombosis. Omphalitis in children may result in splenoportal stenosis and congestive splenomegaly. There is considerable speculation regarding the relationship of Banti's disease and portal hypertension, and it may be that the findings described by Banti may be only the results of splenic vein obstruction, regardless of the cause. The long history of repeated episodes of painless gastrointestinal hemorrhage associated frequently with easy bruising is suggestive of portal hypertension. The presence of an enlarged spleen with pancytopenia, normal or close-to-normal liver function tests, or even negative liver biopsy, are suggestive of extrahepatic obstruction of the portal system, which should be investigated by splenoportography.

Following splenic vein thrombosis, collateral circulation may develop between: (a) the short gastric veins and esophageal veins; (b) short gastric veins and coronary vein; (c) perisplenic veins, retroperitoneal veins and portal vein; (d) left and right gastroepiploic veins; (e) inferior and superior mesenteric veins via the right and left colic veins; and (f) between the perisplenic and left renal veins. The roentgenologic appearance of the obstructed portal system will vary greatly with the site of the obstruction. Three cases of splenic vein obstruction are presented, with 3 different anastomotic patterns, although the site of the obstruction is almost identical, probably because of anatomic variations in the portal system which existed before thrombosis. In one case a lobulated mediastinal mass was visualized on the chest roentgenograms, formed by the greatly dilated para-esophageal plexus of veins. This was demonstrated by splenoportography and proved at surgery. Since no similar case has been reported in the literature, it is suggested that the possibility of dilated esophageal varices should be included in the differential diagnosis of a lobulated mediastinal mass in the presence of a large spleen.—*Walter H. Jarvis, Jr., M.D.*

Ruzicka, Francis F., Jr., Bradley, Edward G., and Rousselot, Louis M. The intrahepatic vasculogram and hepatogram in cirrhosis following percutaneous splenic injection. *Radiology*, Aug., 1958, *71*, 175–186. (Address: F. F. Ruzicka, Jr., St. Vincent's Hospital, 153 W. 11th St., New York 11, N.Y.)

The technique of splenoportography permits visualization not only of the extrahepatic portal vessels but also of the intrahepatic vasculature through its opacification. This intrahepatic visualization is seen in two phases: first, the vasculogram from the intrahepatic portal vein branches, and second, the hepatogram due to presence of the medium in the sinusoids which gives the liver a diffuse opacification.

The normal intrahepatic portal tree shows a symmetric arborization with evenly distributed branches which gradually diminish in size until only the small and fine end branches are seen. The abnormal vasculogram may show local or diffuse changes. Local changes such as local loss of small branches and obliteration or displacement of larger branches may be due to space-occupying masses such as primary or metastatic cancer or inflammatory masses. These are difficult to recognize unless they are fairly large. Diffuse changes such as distortion and blunting of intrahepatic portal vessels with a gnarled or tortuous pattern of the large vessels may be seen in cirrhosis, especially in the small contracted liver. The smaller vessels often are not visualized.

The hepatogram which usually follows the vasculogram shows normally a diffuse homogeneous liver opacification. In the presence of cirrhosis a mottled pattern is most frequently observed, while space-occupying masses will cause localized areas of non-opacification. Usually an abnormal hepatogram follows an abnormal vasculogram, although this is not always true.

This study based on 42 splenoportographies in patients with cirrhosis showed no relationship between abnormal vasculograms and hepatograms and the function of the liver as measured by liver-function tests. Also, there was no relationship between duration of the vasculogram and the density of the hepatogram. Approximately 71 per cent of these cirrhotic patients had abnormal intrahepatic portal vasculograms. If the vasculogram showed a duration longer than ten seconds after the end of injection there was a greater tendency to an abnormal hepatogram. —*Donald N. Dysart, M.D.*

Wylie, Edwin, J., and Goldman, Leon. The role of aortography in the determination of operability in arteriosclerosis of the lower extremities. *Ann. Surg.*, Sept., 1958, *148*, 325–342. (From: Department of Surgery, University of California School of Medicine, San Francisco, Calif.)

This article is a thorough presentation with many illustrations of the use of aortography in arteriosclerosis of the arteries of the lower extremities.

The technique used involves infrarenal injection of the abdominal aorta except when clinical findings in-

dicate thrombosis of the abdominal aorta; then a suprarenal approach is employed. Simultaneous injection through two 17 gauge needles permits rapid injection without so much hazard of hemorrhage as when larger needles are used. In the majority of aortographies, 70 per cent urokon was the contrast medium utilized; 40 cc. was found to be the minimum volume that produced uniform adequate opacity. Four to five serial exposures were made on paired 14 by 17 inch films enclosed in a 36 inch cassette. A wafer grid was placed over the plywood tunnel.

This type of examination enabled the surgeon to more accurately determine the proximal level of occlusion than by clinical means alone. It was possible to better diagnose multiple obstructive lesions, the distal extent of gross disease, and intimal changes in the distal parent arterial segments. All of these had an important bearing on operability. If surgery was to be done, all helped in determining the types of procedure to be done and the best sites for these procedures.

The major significant error in interpretation was invariably that of underestimating the extent of disease.

Complications were 25 renal, 1 neurologic, and 3 intestinal in 500 cases. Twenty-five of these occurred when the site of injection was suprarenal. One fatality was due to uremia, following thrombosis of the renal arteries two weeks after aortography. The suprarenal injection site had been used in this patient.—*George A. Miller, M.D.*

General

Ansell, George. Complications of adrenocortical therapy; a radiological survey. *J. Fac. Radiologists*, July, 1958, *9*, 115–126. (From: The Departments of Radio-diagnosis, The University of Liverpool, and Broadgreen Hospital, Liverpool, England.)

Cortisone and other adrenocortical hormones may produce dramatic improvement in various disease states, but undesirable side-effects may develop at times. Roentgenologic changes may be produced by some of these complications. The beneficial effects and the complications are both related to the normal hormonal actions of adrenocortical therapy. This paper is based largely on a study of some 140 patients' records in whom steroid therapy was begun during the years 1952 to 1955. The adrenal cortex under the influence of the adrenocortical hormone (ACTH) of the anterior pituitary secretes hormones. The activities of these hormones can be classified arbitrarily under two main headings: (a) mineralocorticoid and (b) gluco-corticoid. The former relates to sodium retention, water retention and potassium loss; the latter, to anti-inflammatory, anti-allergic, antitoxic, anti-anabolic, gastric secretory, diabetogenic (water regulating), mental stimulating, virilizing and hematologic activities .The complications of interest to the radiologist include those caused by fluid retention, spread of infection, masking of symptoms, peptic ulceration and osteoporosis.

Pulmonary edema and cardiac enlargement are frequently seen in therapy of Addison's disease with the mineralo-corticoid substance, deoxycorticosterone acetate (DCA). ACTH and cortisone when used in large doses also may cause sodium and water retention. There may be transient pulmonary edema and congestion and also evidence of edema of the interstitial pulmonary tissues, particularly of the interlobular septa, producing the "B lines of Kerley" at the lung bases. With the newer steroids, prednisone and prednisolone, which have a predominantly gluco-corticoid action, sodium and fluid retention usually does not occur. Hence, they are preferable in patients with heart disease in whom it is desirable to avoid fluid retention.

Steroid therapy, sometimes in very high dosage, is indicated in treating two of the collagen diseases—polyarteritis nodosa and systemic lupus erythematosus. These diseases customarily present evidence of pleural effusion, cardiac enlargement, pericardial effusion, and pulmonary opacities with pulmonary congestion and edema. However, such changes may be produced by overdosage with steroids, and hence a problem in differential diagnosis may arise.

Pulmonary Infections. The beneficial effects of adrenal steroids in diseases such as rheumatoid arthritis are due to the anti-inflammatory action of steroids. However, this anti-inflammatory action by depressing the defense mechanisms may lead to spread of infections, such as in the exacerbation of pulmonary tuberculosis. It is necessary to use extreme caution in assessing the quiescence of pulmonary tuberculosis in patients who are to receive steroid therapy. If any doubt exists, it would probably be advisable to administer antituberculous chemotherapy in conjunction with steroid therapy. Again, where there is the slightest suspicion of an acute infection during steroid therapy massive chemotherapy should be instituted immediatelv.

Gastrointestinal Complications. One of the more serious and occasionally fatal complications of adrenocortical therapy has been the liability to peptic ulceration. Peptic complications during adrenocortical therapy may be manifested by (1) exacerbation of a pre-existing peptic ulcer; (2) perforation of an apparently recent acute ulcer; and (3) gastrointestinal hemorrhage, due either to exacerbation of a pre-existing ulcer or arising *de novo*. The impression is gained from various case reports that there may be a somewhat higher incidence of dyspeptic symptoms associated with the use of ACTH, prednisone and prednisolone than with cortisone and hydrocortisone.

Colonic Perforation. Patients with ulcerative colitis may improve dramatically with adrenocortical therapy, but a number of cases of colonic perforation have been reported, during such treatment. More-

over, there is the risk that the masking and anti-inflammatory effects of the adrenal steroids may obscure the clinical picture of perforation and lead to spread of infection.

Skeletal Complications. Rheumatoid arthritis is probably the commonest of the conditions for which steroid therapy has been used. There is no unanimity of opinion concerning the precise indications for, and effects of this therapy, and it is difficult to assess the effects of such therapy on the structural changes in the joints.

Osteoporosis and pathologic fractures frequently occur during ACTH and cortisone therapy. Such complications appear to be more frequent in patients already predisposed to osteoporosis, such as postmenopausal women or patients who have been immobilized. The osteoporosis produced by the adrenal steroids appears to be due to their anti-anabolic action, and testosterone may be effective in prophylaxis.

Infective changes. Steroid therapy may predispose to infective changes in the skeletal system resulting from diminished resistance to infection produced by ACTH. A case of vertebral osteomyelitis probably secondary to septicemia from cellulitis of the skin resulting from diminished resistance to infection induced by ACTH is cited.

The author concludes that the purpose of the paper is to familiarize the radiologist with the various appearances and diagnostic difficulties that he may encounter during steroid therapy, and to consider what contribution radiology can make to the safe use of a valuable group of drugs.—*Samual G. Henderson, M.D.*

Allen, Joseph H., Jr., and Riley, Harris, D., Jr. Generalized cytomegalic inclusion disease, with emphasis on roentgen diagnosis. *Radiology*, Aug., 1958, *71*, 257–262. (Address: J. H. Allen, Jr., Vanderbilt University Hospital, Nashville 5, Tenn.)

Generalized cytomegalic inclusion disease is a systemic disease, primarily in infancy, characterized by the presence of intranuclear and intracytoplasmic inclusion bodies in enlarged cells of a variety of viscera. It has also been known as generalized salivary gland virus disease, inclusion disease, and protozoan cell disease. The disease may be divided into four main categories: (a) the subclinical variety found in the submaxillary glands and other organs at autopsy on stillborn or newborn infants dying of other causes; (b) poorly understood cases occurring apparently in association with other diseases, such as pertussis; (c) postulated cases with mild manifestations and recovery; and (d) the systemic or generalized variety, which is usually lethal.

In children under two years of age, the condition is primary and fatal. In older children, it is more often associated with another disease and plays a minor role. The clinical picture is extremely varied and depends on the degree and site of involvement. In the newborn infant which has acquired the disease transplacentally the usual manifestation is a hematologic disturbance or jaundice. Thrombocytopenia may occur with petechial hemorrhage, hemolytic anemia, purpura, hematuria, melena, hematemesis, or cerebral hemorrhage. Hepatosplenomegaly is often present. Macrocephaly, microcephaly, convulsions, and intracranial calcification have all been reported.

Antemortem diagnosis of cytomegalic inclusion disease is made most readily by demonstration of inclusion cells in the urinary sediment. Roentgen findings of interest are seen in the group manifesting the disease at birth. Visible calcification outlining the dilated lateral ventricles, when it occurs, is virtually diagnostic. Calcific deposits have also been observed in the cerebral cortex and subcortical white matter. Bone changes have been reported by some authors. Marked diffuse bony sclerosis may be demonstrable at birth, with atrophic changes becoming apparent in later months.

Two cases of generalized cytomegalic inclusion disease occurring in infants are reported by the authors. —*Arno W. Sommer, M.D.*

Zelman, Samuel, and Lewin, Hans. Adult agammaglobulinemia associated with multiple congenital anomalies. *Am. J. Med.*, July, 1958, *25*, 150–154. (From: Winter Veterans Administration Hospital, Topeka, Kans.)

A case of agammaglobulinemia is presented associated with multiple congenital anomalies. Blood studies on the parents of this patient revealed hypergammaglobulinemia.

Roentgenographic examination showed that the spleen, liver, stomach, and duodenum were on the right side with only the descending colon and jejunum in the left side of the abdomen. There was hyperostosis of the frontal and parietal bones with sclerosis of the diploe. A density posterior to the neural arch of the atlas was thought to represent an independent apophysis of the posterior tubercle. A spina bifida occulta of the sacrum was seen with ossification of a small apophysis in the middle of the otherwise unossified neural arch.

Because of the multiple congenital anomalies, it was felt by the authors that such an adult "acquired" agammaglobulinemia could well represent another congenital anomaly on a possible hereditary basis with the presence of hypergammaglobulinemia in both the parents.—*Cecil W. Ely, M.D.*

Feldman, Arnold, Babcock, George C., Lanier, Raymond R., and Morkovin, Dimitry. Gonadal exposure dose from diagnostic x-ray procedures. *Radiology*, Aug.,

1958, *71*, 197–207. (Address: A. Feldman, 4200 East Ninth Ave., Denver 20, Colo.)

The dose the gonads received during diagnostic roentgenologic procedures depends for the most part on whether or not they are in the useful beam at the time of exposure. If they are in the useful beam the dose is due to the primary radiation plus scattered radiation and can be calculated from the known exposure dose in air at the body surface distance and from a depth dose chart. If the gonads are outside the useful beam the dose is due almost entirely to scattered radiation. This dose is difficult to figure as charts giving dose information for points outside the useful beam are not readily available.

Other factors influencing the gonadal dose are the physical factors which include: (1) kilovoltage and wave form, (2) milliamperage, (3) exposure time, (4) number of exposures per examination, (5) filtration, (6) distance, (7) field size, (8) cone or diaphragm, (9) tube housing, (10) distance from central ray in a plane perpendicular to central ray, (11) thickness of underlying and overlying tissue, (12) type of tissue, (13) thickness of adjacent body parts, and (14) local shielding. The effects these various factors had on the gonadal dose were studied by the authors at the University of Colorado Medical Center. Dose measurements were obtained in patients during actual examinations, as well as in phantoms and cadavers. As a result of this study a chart was prepared which gave the dose to the gonads for each type of examination performed on both males and females. The authors stress, however, that this chart is applicable only to their own department as physical factors may vary considerably in other departments.

One simple procedure of shielding the male gonads while exposing films of the lumbar spine or abdomen was found to reduce the dose to the gonads to less than one-tenth of that when no local shielding was used. The problem of shielding the female gonads is greater, however, as most of the dose they receive is due to "internal scatter", but local shielding with a lead screen will help some. It is hoped by the authors that radiologists will study their techniques and then select those that give the least dose consistent with adequate examination.—*Donald N. Dysart, M.D.*

Lincoln, T. A., and Gupton, E. D. Radiation doses in diagnostic x-ray procedures. *Radiology*, Aug., 1958, *71*, 208–215. (Address: T. A. Lincoln, Post Office Box X, Oak Ridge, Tenn.)

A study designed to determine the dose to the skin at the focal point of entry and to the gonads of adult patients during certain diagnostic procedures has been conducted at the Oak Ridge National Laboratory. A system has been inaugurated for the Oak Ridge National Laboratory population to record such doses. From experimental methods, which also included the use of a tissue-equivalent phantom, a typical dose for the skin, ovaries, and testes was assigned for each diagnostic procedure. On the basis of these measurements factors were applied to the data from two hospitals and two clinics in order to estimate the dose which might have been obtained with the phantom. The study included equipment and techniques which resulted in doses comparable to both the highest and lowest reported in the literature.

For diagnostic procedures adequate exposure to radiation of the proper quality is required; however, when the quantity and the quality of radiation are established, a relatively large reduction in dosage, as well as improvement in the quality of the roentgenogram, may be accomplished by the use of masks, filters, and cones. The dose to the gonads can be reduced by the use of a high-kilovoltage and heavy-filtration technique when the diagnosis concerns that vicinity. Such a technique, however, has little advantage for the extremities. Roentgenographic techniques have been modified also by incorporating additional filtration and using Eastman Kodak Royal Blue film, which has a speed approximately two times that of the film used previously. Large reductions were thus accomplished in the doses delivered to the patient.

If recommended techniques are employed doses to the gonads from diagnoses involving the extremities, including dental films, may be made quite small and may be ignored in tabulating the total or average dose received by a population group. On the other hand, accurate knowledge of the average genetic dose depends heavily on accuracy in determining gonad doses due to diagnoses involving the midsection and the pelvis. High-voltage techniques combined with maximum coning and filtration would simplify the estimation of these as well as reduce the dose itself. Data are insufficient for assigning values of the average genetic dose to large populations. There are indications that the present doses could be reduced by factors of 4 to 10 by application of relatively simple and inexpensive techniques. Such techniques will permit reasonably accurate doses to be estimated and kept as part of medical records. From these records, average doses to large population groups can be obtained.—*Walter H. Jarvis, Jr., M.D.*

Garrett, R., Tamusz, O., Meurk, M. L., Laughlin, J. S., and Sherman, R. S. Dose measurement technics for diagnostic procedures. *Radiology*, Aug., 1958, *71*, 216–221. (Address: R. Garrett, Memorial Center, 444 E. 68th St., New York 21, N.Y.)

During routine diagnostic roentgenologic procedures, a certain amount of direct or scattered radiation will reach the active bone marrow and gonads. To

measure this, the authors constructed a pressdwood phantom into which a wax impregnated skeleton was inserted. The marrow which had been removed, was replaced with pure beeswax of 0.97 gm./cc. density. The lung was simulated with cork of density 0.3 gm./cc. Ionization chambers were placed within the phantom at three positions in the spine (C-7, T-6, and L-1), one in the ilium, one at the upper end of the femur, two in the scrotum, two in the ovarian region and at the entrance and the exit field surfaces.

At the present time, the authors are developing special miniature ionization chambers designed so that the chamber response is relatively independent of changes in energy of the roentgen-ray beam used in the diagnostic procedures; i.e., 3 mm. Al half-value layer and lower. Most commercial chambers are designed for the heavy-energy region and below a half-value layer of 5 mm. Al they exhibit a rapid fall-off in response. This is due to the absorption of these softer rays in the walls of the chamber itself. The construction and properties of these special chambers are described.

Of the various commercial ionization chambers available, the Landsverk "finger" ionization chamber was chosen for the present study. Each chamber was calibrated for variations in response to energies between half-value layers from 0.3 mm. Al to 3.0 mm. Al. This variation was found to be about 35 per cent. The chamber discharge was measured with the Baldwin-Farmer electrometer which was fitted with adapters to accommodate the Landsverk chambers, which were charged to 250 volts.

Three diagnostic procedures were performed: (1) posteroanterior 14×17 inch chest roentgenography; (2) posteroanterior chest photofluorography with F 1.5 lens; and (3) anteroposterior 14×17 inch lumbar spine roentgenography. The physical factors used were based on the size and shape of the phantom, which represented a medium-sized young adult. The roentgenologic unit was set up in exactly the same manner as for routine roentgenography. The relative skin, bone-marrow and gonadal doses obtained during these procedures were measured and are tabulated. The average and integral bone-marrow doses for the three procedures are also tabulated. A comparison is made between these doses and the estimated yearly bone-marrow and gonadal dose due to natural background radiation. The former is estimated at 135 mr per year, the latter at 104 mr per year. It was found that the background gonadal dose per year is about twenty times that due to one chest roentgenogram and about equal to that for one lumbar spine examination. The average bone-marrow dose from Procedure 1 is about one-tenth of yearly background whereas the doses from each of Procedures 2 and 3 are about equal to the yearly background dose.—*Z. Petrany, M.D.*

Vacirca, S. J. Some useful radiation protection devices. *Radiology*, Aug., 1958, *71*, 222–226. (Address: Department of Physics, Memorial Center, 444 East 68th St., New York 21, N.Y.)

The author reports several devices used at Memorial Center for Cancer and Allied Diseases (New York) which facilitate the handling of radioactive material and afford protection to personnel working in the area. A device for storing radium applicators in the operating room is described. This accommodates any of the commonly used radium applicators while they are undergoing cold sterilization. The walls, cover, and bottom are made of 2½ inch thick lead which reduces the radiation from the enclosed radium to approximately 3 per cent. This container is transportable from room to room by means of rubber rimmed wheels and has a heavy cover supported by ball-bearing rollers that affords easy accessibility in spite of its weight.

A radioisotope disposition board on which is recorded the disposition and type of radioactive materials throughout the hospital has been found useful by the author. The board is laid out according to floors and areas with various colored cards used for the different isotopes. The date, amount of radioactivity, name and location of the material are written on each card. This affords a measure of control over the various radioactive substances in a large institution.

An F-block or modified L-block is used in the preparation of radioactive seeds. This block, weighing 150 lbs. is mounted on a cart which can easily be draped and used in a sterile field so that the needles need not be loaded until the time of implantation. The L-block is modified by the addition of a 2×4×8 inch lead brick to the base of the standard L-block, and a thin spring stainless steel clamp. The clamp holds a tray in which needles are placed after being loaded behind the upright of the L-block. This affords an extra 2 inches of lead in front of the loaded needles in the tray.

To reduce exposure to personnel when portable chest roentgenograms are taken, a patient cassette holder was devised which is essentially a tunnel for a film cassette. The addition of arm supports to prevent slipping of the patient and a back support that rests on the mattress obviates the use of personnel in holding the cassette or patient during the exposure.—*John S. Alexander, M.D.*

Hale, John, Kusner, David B., Gorson, Robert O., and Bartsch, James R. Radiation safety evaluation of fluoroscopes. *Radiology*, Aug., 1958, *71*, 227–235. (Address: J. Hale, Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia 4, Pa.)

The authors describe their methods of evaluating the radiation safety of fluoroscopes. Although the extent of exposure depends largely on the technique of

the fluoroscopist, there are certain inherent radiation characteristics in each machine such as the exposure dose rate, the quality of radiation produced by the machine, and the scatter from the machine that may be measured and compared to a standard in reference to experience and criteria set forth by the National Committee on Radiation Protection in the National Bureau of Standards Handbook 60.

In calibrating the inherent radiation characteristics of a given fluoroscope, the authors first determine the exposure dose rate in air at table top. In this measurement, the field area, table top-screen distance, and table top-chamber distance must be standardized for the machines being compared. The authors use a 10×10 cm. field size with the chamber as close to the table top as possible. Due to the impracticality of measuring the total filtration, the authors use the concept of the half-value layer. This half-value layer may be measured by transmission curve methods or by inferential measurements which are described in detail. The minimum acceptable half-value layer has been taken to be 2.5 mm. of aluminum under normal operating conditions.

The measurement of scattered radiation by means of isoexposure dose rate curves in the transverse plane through the fluoroscopic screen is discussed. These measurements are made with an ionization survey meter. The use of lead fillers of 0.25 mm. lead equivalent at 100 kv. peak for Bucky slots, 0.25 mm. lead equivalent curtains attached to the screen, and sideboards are recommended to reduce scattered radiation. Other safety considerations include inspection of protective garments and gloves for signs of deterioration, testing the adjustable diaphragm to assure that a margin of at least ¼ inch of unilluminated screen is left regardless of screen position, checking the cumulative exposure time and the transmission through the protective lead glass above the fluorescent screen.—*John S. Alexander, M.D.*

Tanner, J. M., Whitehouse, R. H., and Powell, J. H. Armadillo; a protective clothing as a shield from x-radiation. *Lancet*, Oct. 11, 1958, *2*, 779–780. (From: Institute of Child Health, University of London, the Harpenden Growth Study, and I. T. Henderson & Co., Ltd., London, England.)

A new material for lead protective shielding is presented by the authors. The material is made of a series of lead scales each sealed in a flexible plastic envelope and imbricated so as to overlap its neighbor both above and below and from side to side. This material is called "Armadillo."

The primary advantage of Armadillo is its great flexibility so that it may be fashioned as clothing.

Though the scales are of 0.25 mm. of lead, due to the overlap of the scales, transmission data at 75 kv. peak show the equivalent thickness to be 0.3–0.4 mm. lead.—*George A. Miller, M.D.*

RADIATION THERAPY

Harper, Paul V., and Lathrop, Katherine. Implant radiation therapy for carcinoma of the pancreas. *A.M.A. Arch. Surg.*, Oct., 1958, *77*, 613–620. (From: The Argonne Cancer Research Hospital [U.S.A.E.C.] and the Department of Surgery, University of Chicago, Chicago, Ill.)

The authors describe in detail an ingenious method of interstitial radiation therapy for carcinoma of the pancreas. Polyethylene tubing is sewed through the tumor conforming to Patterson and Parker distribution rules, the free ends being led through the abdominal wall. At any convenient later time iodine 131 is introduced in such quantity as to deliver several thousand rads to the implanted volume. Twelve cases are presented.

The authors conclude that palliation is significant enough to warrant further exploration of the method. Radiobiologic peculiarities of this region, namely a resistant tumor variety and a highly sensitive small bowel, would seem to militate against success of this method. The technique is basically an adaptation to peculiar anatomic problems. One would like to see it used in a situation where the therapeutic ratio is more favorable. Reduction of exposure to personnel is a most welcome feature of the method described.—*Patrick J. Cavanaugh, M.D.*

Gray, Mary Jane, Gusberg, Saul B., and Guttmann, Ruth. Pelvic lymph node dissection following radiotherapy. *Am. J. Obst. & Gynec.*, Sept., 1958, *76*, 629–633. (From: The Department of Obstetrics and Gynecology and the Department of Radiotherapy, Columbia University College of Physicians and Surgeons, the Sloane Hospital for Women, and the Francis Delafield Hospital, New York, N.Y.)

Fifty-one patients with Stage I and II carcinoma of the cervix were submitted to pelvic lymphadenectomy three months after completion of radiation therapy. Of 28 Stage I cases none had involved lymph nodes; of 23 Stage II cases one had a positive lymph node. A similar group of 61 Stage I and II patients receiving a radical hysterectomy as sole treatment had lymph node involvement in 18 per cent.

This report confirms other studies which show that radiation therapy is able to sterilize an appreciable percentage of metastatic pelvic lymph nodes. Twenty of the patients had major complications requiring hospitalization. These were assumed to be related to the dose. The external therapy was given by a variety of means in doses from 3,500 to 6,000 r. The question is raised whether the doses, times, and various qualities can be correlated with the degree of postoperative morbidity.—*Patrick J. Cavanaugh, M.D.*

Bekerus, Milos, Gudden, Friedrich, and Weitzel, Günter. Die Beeinflussung der Elektronen-Tiefendosisverteilung eines 15 MeV-Betatrons durch vorgeschaltete Aluminiumfolien. (The alteration of the electron-depth dose distribution from a 15 mev. betatron by aluminum foils.) *Strahlentherapie*, Sept., 1958, *107*, 117–120. (From: Czerny-Krankenhaus für Strahlenbehandlung der Universität, Heidelberg, Germany.)

Aluminum foil filters placed on the skin shift the maximum dose level of the electron beam upward, toward the skin, and change the depth dose distribution curve into approximately a straight line. Judicious selection of such filters can therefore be used to advantage in avoiding use of the technically unfavorable lowest betatron energies.

The several curves reproduced deal with 3 and 6 mev. beams filtered with 3 mm. of Al.—*Henry G. Moehring, M.D.*

Buttenberg, Dietrich, and Lau, Hans. Indirekte Dosierung bei intrauteriner Bestrahlung durch Kobalt^{60}-Perlen. (Indirect dosage determination in intrauterine irradiation with radioactive cobalt 60 beads.) *Strahlentherapie*, Aug., 1958, *106*, 593–600. (From: Universitäts-Frauenklinik, Heidelberg, Germany.)

The average tolerance of urinary bladder and intestine to radium radiation is 6,500–7,000 r administered at one sitting. This tolerance is higher if the dose is protracted and fractionated. The authors decided to use this tolerance as a limiting factor in radiation therapy of pelvic malignancies treated with intrauterine beads of Co^{60} plus external radiation. The difficulties of measuring radiation dose to uterus was an added stimulus to use such an indirect method; *i.e.* the physical measurement of radiation intensity from the Co^{60} beads by placing the probe of a gamma-meter against the posterior bladder wall at the point of maximum radiation intensity, after the uterus had been packed with the radioactive beads. Measurements on cadavers and on several patients demonstrated that the dose to bladder was always higher than to the rectum, so the bladder was chosen as the point of measurement. The dose to bladder wall from external radiation was calculated. The intrauterine beads were left in place long enough to bring the total (from external source plus the beads) dose to bladder mucosa to 4,000–6,000 r.

The authors have used this method in 102 insertions of Co^{60} beads in 70 patients: 35 with carcinoma of the uterine corpus; 33 with ovarian carcinoma; and 2 with uterine sarcoma. They have observed no severe mucosal reactions in urinary bladder or in the rectum; no "supralethal" effects; and, to the present, no residual carcinoma in the uterine cavity in patients who had carcinoma of the uterine corpus.—*Henry G. Moehring, M.D.*

Uhlmann, Erich M. Ein 45-Millionen-Volt-Linearbeschleuniger als Elektronenquelle für die Behandlung tiefliegender Karzinome. (A 45 mev. linear accelerator as an electron source for the treatment of deep-seated carcinoma.) *Strahlentherapie*, July, 1958, *106*, 319–334. (From: Michael Reese-Hospital, Chicago, Ill.)

The author describes many of the details of the 45 mev. linear accelerator: physical arrangement, radiation safety precautions, depth dose determinations, and relative biologic effect (2:1 as compared with 200 kv. irradiation insofar as lethal effect on mice; from 1.2–1.4:1 in estimated clinical effect).

He reports good therapeutic results in several patients.—*Henry G. Moehring, M.D.*

Becker, Josef, and Scheer, Kurt Ernst. Das Beta-Mosaik: Eine anpassungsfähige Strahlenquelle für die Oberflächentherapie. (The beta-mosaic: an adaptable radiation source for superficial therapy.) *Strahlentherapie*, Sept., 1958, *107*, 112–116. (From: Czerny-Krankenhaus für Strahlenbehandlung der Universität, Heidelberg, Germany.)

Yttrium^{90} embedded in a plastic film is an excellent source for superficial beta-radiation. The plastic film is cut into hexagons one centimeter in diameter and covered, top and bottom, with a similar hexagon of inert plastic film. These hexagons are stuck to the skin with an adhesive that is either brushed or sprayed on, side by side to cover the area to be treated, no matter how irregular. The film adapts itself even to sharply curved surfaces. Radiation intensity can be measured at the external surface of the three-layered film and if any radiation hazard exists, the external surface can be shielded with 1 mm. lead foil. If the mechanical arrangement is appropriate, the entire application is then covered by adhesive tape or a bandage.

Such an applicator is most suitable to medium-sized areas; *e.g.*, flat cavernous nevi.—*Henry G. Moehring, M.D.*

RADIOISOTOPES

Baker, William J., Lutterbeck, Eugene F., Graf, Edwin C., Callahan, Daniel H., and Firfer, Raymond. A new method for handling radioactive gold in the treatment of prostatic cancer. *J. Urol.*, Sept., 1958, *80*, 189–191. (Address: W. J. Baker, 7 W. Madison St., Chicago 2, Ill.)

In the administration of radioactive gold for the treatment of prostatic carcinoma, it is necessary that

the radioactive material be adequately distributed, sufficient in amount, and that adequate protection against radiation hazards be available.

In this paper the authors introduce a new method of handling radioactive gold during the interstitial injection. The major variation of this method from previously published methods is that the surgeon does not hold the syringe containing the radioactive material in his hand at any time. To avoid this, a 4 foot long, No. 20 gauge needle, attached to a two-way valve is handled with a sterile ring forceps. The rest of the equipment consists of the pressure syringe of the modified Getzoff type, a 10 cc. standard Luer Lock syringe mounted in a lucite cylinder. The Luer Lock syringe has distinctive green calibration marks so that they can be easily identified through the purple colored colloidal gold preparation. The screw type plunger is operated from a distance by a horizontal bar which raises or lowers the plunger of the 10 cc. syringe. The entire apparatus is mounted on the horizontal arm of a modified drill press so that it can be moved from one solution to another affording the opportunity of using a solution of hyaluronidase with epinephrine mixed with the radioactive material.

The authors have used the perineal method of approach entirely for this purpose. At operation, the urologist places the Silverman needles through the perineum to the tumor area, removes the obturators of the needles and inserts a No. 20 gauge needle for the injection of the radioactive material. Proper precautions are taken to prevent any leakage. The radiologist is responsible for injection of the proper amount of material. The average case requires 25–30 mc of radiogold in each lobe of the prostate in order to deliver a tumor dose of 6,000 to 8,000 gamma roentgens. The operating room personnel receives no more than 40 mr radiation exposure during the procedure. One photograph of the equipment is included in this excellent article.—*George W. Chamberlin, M.D.*

Born, Willi, C. Beseitigung radioaktiver Verunreinigungen von der Haut des Menschen. (Removal of radioactive contaminants from human skin.) *Strahlentherapie*, July, 1958, *106*, 435–445. (From: Universitäts-Hautklinik, Freiburg i. Br., Germany.)

Adhesive tape is a simple, practical, effective, and generally available method for removing radioactive contaminants from the skin. In hairy areas, shaving should precede the application of the tape. If the skin is greasy, washing with ether should precede use of the tape. Strips of tape are applied to the contaminated area with firm pressure and then immediately removed; the process is repeated a number of times so that both contaminants and the cornified layers of skin are removed.

Since silicones do not stick to adhesive tape, contamination of an area also contaminated by silicones will resist removal by this method.—*Henry G. Moehring, M.D.*